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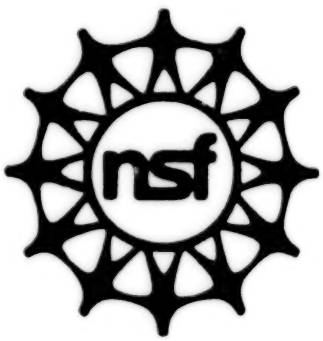
NATIONAL SCIENCE FOUNDATION

SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Abstracts of Phase I Grants
September 1981



Division of Industrial Science and Technological Innovation (ISTI)
Directorate for Scientific, Technological, and International Affairs (STIA)
National Science Foundation
Washington, DC

March 1982

23 AUG 1982

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I

Table of Contents

Introduction ix

Topic 1 - Materials Research

Fusion Casting of Refractories in a Centrifugal Plasma Furnace
Center for Innovation, Inc., Butte, MT 1
Grain Boundary Phases in Structural Ceramics
Ceramic Finishing Company, State College, PA 1
Fiber-Reinforced Microcracked Ceramics
Fiber Materials, Inc., Biddeford, ME 2
Chemical Vapor Deposition of Amorphous Silicon
Solarex Corporation, Rockville, MD 3
Ion Beam Deposition of Cubic Boron Nitride as a Hard Coating from Borazine
Spire Corporation, Bedford, MA 4

Topic 2 - Bio-Sources of Materials

Production of Cellulose Powders Using Cellulase Enzymes
BioChem Technology, Inc., Malvern, PA 4
Electrocatalytic Reduction of Lignin to Phenolic Feedstocks
Covalent Associates, Framingham, MA 5
Chemicals from Salt Loving (Halophilic) Microbes
Ecoenergetics, Inc., Fairfield, CA 6
In Vitro Production of Saltbush for Revegetation and Range Improvement
Plant Resources Institute, Salt Lake City, UT 6
Antifungal Constituents of Rhamnus Prinoides
SISA Inc., Cambridge, MA 7

Topic 3 - Genetic Technology

No Awards

Topic 4 - Advanced Manufacturing Processes

A Modeling Study of Abrasive-Waterjet Metals Cutting
Flow Technology Company, Kent, WA 8
Computer Control for Small-Hole Grinding
Hahn Associates, Northboro, MA 8
Electromagnetic Transducers for Weld Inspection
Magnasonics Inc., Albuquerque, NM 9
Development and Identification of Operations Research Algorithms for Small Computers
Pritsker and Associates, Inc., West Lafayette, IN 10
The Thermastress Concept for Steel Reinforcing Wire Manufacture
U.S. Automation Company, Warren, MI 11

Topic 5 - Advanced Chemical Processes

Hybrid-Phase Catalysts for the Oxidation of Phenol
Andrulis Research Corporation, Bethesda, MD 11
Electrochemical Production of Ozone
Castle Technology Corporation, Woburn, MA 12

Development of Non-Noble Metal Electrocatalysts
Electrochimica Corporation, Mountain View, CA 13
A New Class of Separating Agents
Merix Corporation, Babson Park, MA 13

Topic 6 - Industrial Biological Processes

Competitive Inhibitor-Enzyme Immunoassay
Bio-Metric Systems, Inc., Navarre, MN 14
Acoustic Protein Separation
Bonneville Scientific, Salt Lake City, UT 15
The Optimization and Automation of Gene Synthesis
Collaborative Research, Inc., Waltham, MA 15
Antibiotics from Isopods
SISA Inc., Cambridge, MA 16

Topic 7 - Microelectronics

High-Throughput Line Source Electron-Beam Processing of Silicon-on-Insulator Structures for Microelectronics
Advanced Research and Applications Corp. (ARACOR), Sunnyvale, CA 17
Soft X-Ray Source for Microlithography
Mathematical Sciences Northwest, Inc., Bellevue, WA 17
Transient Three-Dimensional Numerical Simulation of Microelectronic Semiconductor Devices
Scientific Research Associates, Inc., Glastonbury, CT 18

Topic 8 - Communications and Systems

On-Line Tool Wear Estimation and Failure Prediction in Metal-Cutting Operations
ALPHATECH, Inc., Burlington, MA 19
Coding for Band-Limited Channels
Cyclotomics, Inc., Berkeley, CA 19
Advanced Control of Electric Arc Furnaces
Scientific Systems, Inc., Cambridge, MA 20
Feasibility Investigation for an Electrostatically bonded Fiber Optic Coupler
Spire Corporation, Bedford, MA 21
Variable Structure Servomechanisms
Systems Engineering for Power, Inc. (SEPI), Vienna, VA 22

Topic 9 - Computer Science and Engineering

Array Processing of the Three-Dimensional Navier-Stokes Equations
Computational Mechanics Consultants, Inc., Knoxville, TN 22
Research into the Structure, Accessing, and Manipulation of Numeric Data Bases: Phase I
King Research, Inc., Rockville, MD 23
Distributed Data Base Management on Local Networks
Relational Technology, Inc., Berkeley, CA 24
Optical Image Analysis of VLSI Microcircuits
Tractell, Inc., Dayton, OH 24

Topic 10 - Robotics and Controls

Advanced Programmable Grey-Scale Vision for Robotics - Phase I
Automatix, Burlington, MA 25
A Study of Robot Vision Techniques Using Acousto-Optic Image Sensors
Deft Laboratories, Inc., East Syracuse, NY 26

Distance Sensor for Robotics
Kazuko Enterprises Inc., Orlando, FL 27
Servo for Industrial Robot with Force Control
Microbot Inc., Mountainview, CA 28
Robotic Camera Improvements
Optra Inc., Everett, MA 28

Topic 11 - Scientific and Industrial Measurements

Compton Backscatter Computed Tomography
Advanced Research and Applications Corporation, Sunnyvale, CA 29
Scanning Spectral Correlator
Aerodyne Research Inc., Bedford, MA 30
Increasing Latent Fingerprint Fluorescence by Means of an Acousto-Optic Output Coupled (Cavity-Dumped) Variable Pulse Width Argon-Ion Laser
ALM, Inc., Arlington, VA 31
An Advanced Detection System for Quantitative Three-Dimensional Ion Microscopy
Charles Evans and Associates, San Mateo, CA 32
A Laser-Based Photoacoustic Method for Measuring Stable Isotope Ratios
KOR, Inc., Cambridge, MA 32
Quantum Ferroelectric Pressure Sensor
Lake Shore Cryotronics, Inc., Westerville, OH 33
Photon Induced Surface Conductivity Requiring the Presence of Sorbed Photoionizable Species
Quantatec International, Inc., Chatsworth, CA 34
Eddy Current Imaging
Spectron Development Laboratories, Inc., Costa Mesa, CA 35

Topic 12 - Radiation Processing and Control

Microanalysis Methods for Inhomogeneous Materials
Advanced Fuel Research, Inc., East Hartford, CT 36
High Current Ion Implantation
Mission Research Corporation, Albuquerque, NM 37
Spatial Resolution in Industrial Tomography
Scientific Measurement Systems, Inc., Austin, TX 38

Topic 13 - Light Machinery and Components

The Direct Action of Electromagnetic Fields on Fluids
Eagle Engineering Inc., Pittsfield, MA 39
Research on Improved Dynamic Torque Control Standard Induction Motors
IMEC Corporation, Boston, MA 39
Bearing Structures Fabricated from Arc Plasma Sprayed Layers Coated with Solid Film Lubricants
Solamat, Inc., East Providence, RI 40
Self Feeding Fluid-Film Bearing
Shaker Research Corporation, Ballston Lake, NY 41

Topic 14 - Advanced Automotive Research

The Application of Resilient Bearings to a Crankshaft of a Diesel Engine
Cambridge Collaborative, Inc., Cambridge, MA 41
Deuterated Additives for Automative Lubricants
KOR, Inc., Cambridge, MA 42
Studies of Woven Fabric Reinforced Composites for Automotive Applications
Materials Sciences Corporation, Blue Bell, PA 42

Topic 15 - Food Process Engineering

Investigation of the Effect of Processing Techniques on the Reduction of Cholesterol and Lipids in Muscle Foods
Webb Foodlab, Inc., Raleigh, North Carolina 43

Topic 16 - Marine Resources

A Feasibility Experiment in Stabilizing Canadian Mussel Seed Transplanted in New England Waters
Abandoned Farm, Inc., Damariscotta, ME 44
Cage Culture of Red Tilapia in Prawn and Shrimp Ponds
Aquatic Farms, Kaneohe, HI 45
Modeling the Coastal Ocean - A Step Towards Marine Forecasting Capability
Dynalysis of Princeton, Inc., Princeton, NJ 45
Development of a New Management Technology for Commercial Prawn Farming: Phase I
Kahuku Prawn Company, Inc., Kahuku, HI 46
Examination of Factors Affecting the Survival of Oysters Infected with the Fungus Labyrinthomyxa Marinum and Applicability of These Factors to Improved Pond Aquaculture
Research Planning Institute, Inc., Columbia, SC 47

Topic 17 - Mineral Resources

No Awards

Topic 18 - Environmental Technology

Engineering Development of a Clean-Burning Residential Wood Stove
Flow Research Company, Kent, WA 48
Basic Mechanism to Achieve Clean Combustion of Oil Shale in Fluidized Beds
Huey Corporation, Morgantown, WV 48
Inhibition of Microbial Growth on Activated Carbon Beds
JTC Environmental Consultants, Inc., Bethesda, MD 49
Inductive Heating of Spent Granular Activated Carbon
QED Corporation, Ann Arbor, MI 50

Topic 19 - Tunneling, Drilling, Excavation, and Dredging

Feasibility Study of a Novel Rock Tunneling and Excavation Method
Flow Technology Company, Kent, WA 50
Self-Resonating High Pressure Water Jets for Tunneling, Excavation, and Mining
Hydronautics Inc., Laurel, MD 51

Topic 20 - Earthquake Engineering

In-Situ Determination of Damping of Soils
Advanced Technology and Research, Inc., Silver Spring, MD 52
Seismic Hazard Assessment of Non-Structural Ceiling Components
ANCO Engineers, Inc., Culver City, CA 53
Alternative Methods for Hazard Reduction in Unreinforced Masonry Buildings
Michael E. Durkin and Associates, Woodland Hills, CA 53
Field Index Test for Estimating Liquefaction Potential
Geotechnical Engineers, Inc., Winchester, MA 54
Tomographic Assessment Techniques for Earthquake Engineering
Scientific Measurement Systems, Inc., Austin, TX 55
Comprehensive Computer-Aided Earthquake Analysis and Program Development for Business and Industry
Scientific Service, Inc., Redwood City, CA 56

Topic 21 - Science and Technology to Aid the Handicapped

Impedance Test for Intramedullary Anchored Femoral Prosthesis Loosening
Advanced Mechanical Technology, Inc., Newton, MA 57
Biotechnical Multi-Electrode/Neuronal Interface
EMV Associates, Inc., Rockville, MD 57
The Study of Fatigue Mechanisms in a 3-D Carbon-Carbon Composite
Fiber Materials, Inc., Biddeford, ME 58
Natural Gum Substitute for Karaya Gum for Ostomy Products
Technology Transfer Concepts International, Neenah, WI 59
A New Signal Processing Concept Applicable to Hearing
Time/Space Systems, Endicott, NY 59

Topic 22 - Appropriate Technology

Integrated Energy-Agro-Waste Systems for Small-Scale Farms
Cal Recovery Systems, Inc., Richmond, CA 60
Ecological Principles of Stability as a Means of Understanding the Role of Appropriate Technology in Agriculture
Dow Associates, Inc., Berkeley, CA 61
Reducing/Separating Recoverable Demolition Wastes with Cavitating Water Jets
Hydronautics, Inc., Laurel, MD 61
Rate of Biodegradation of Toxic Organic Compounds While in Contact with Organics Which Are Actively Compositing
Snell Environmental Group, Inc., Lansing, MI 62
Characterization of Three-Metal Galvanic Cells in Seawater
Thomas C. Wilder, Waltham, MA 62

Follow-on Funding Commitment 65
Alphabetical List of Awardees (Including Business Officer) 67

NSF SMALL BUSINESS INNOVATION RESEARCH PROGRAM

ABSTRACTS OF 1981 PHASE I AWARDS

In September 1981, the National Science Foundation (NSF) announced 86 Phase I awards totaling $2.5 million to small science- and technology-based firms. The awards, made through the Foundation's Small Business Innovation Research (SBIR) program, recognize the role such firms play in research and its conversion into technological innovation in the economy. This publication provides abstracts of the research grants and brief comments on the potential commercial application as described by the awardee.

The primary aim of the SBIR program is the support of advanced research on important scientific and engineering problems and opportunities that, if the research is successful, could lead to significant public benefit. A second important goal is the conversion of NSF-supported research into industrial applications and technological innovation where appropriate. To accomplish this goal, the program's design encourages the small firm to pursue potential commercial applications of the Government research with follow-on private venture capital or other funding. Federal funds support only research consistent with NSF program objectives.

The program is highly competitive. A total of 696 proposals were received under the 1981 SBIR program from 43 states and the District of Columbia. Firms receiving awards ranged from a start-up one-man firm to a company with 425 employees.

The 86 awards were made for advanced research in the following areas of potential application:

1. Materials
2. Bio-sources of Materials
3. Genetics
4. Advanced Manufacturing Processes
5. Advanced Chemical Processes
6. Industrial Biological Processes
7. Microelectronics
8. Communications and Systems
9. Computer Science and Engineering
10. Robotics and Controls
11. Scientific and Industrial Measurements
12. Radiation Processing and Control
13. Light Machinery and Components
14. Advanced Automotive Research
15. Food Process Engineering
16. Marine Resources
17. Mineral Resources
18. Environmental Technology
19. Tunneling

20. Earthquake Engineering
21. Science and Technology to Aid the Handicapped
22. Appropriate Technology

The Phase I awards are for up to $30,000 and 6 months to determine, as much as possible within these limitations, whether the research idea appears technically feasible and whether the small firm can do high-quality research before further Government support takes place. The result is a Phase I report, which normally can serve as a base for follow-on funding commitment discussions.

Phase II is the principal research effort for those projects that appear the most promising after the first phase. These awards have averaged $200,000 for 1-2 years. Phase III is the product or process development phase, and involves the follow-on private funding from venture capital or large industrial firms to pursue potential commercial applications of the Government-funded research. No Government funds are provided in Phase III.

As a result of the first SBIR solicitation, the small companies have obtained more than $47 million from private sources that was directly or in part the result of the SBIR research awards. Firms that have completed Phase II have also, on the average, more than doubled their employment since they submitted their Phase I proposal, and most are coupled with universities with university scientists and engineers serving as consultants.

In the first SBIR solicitation in 1977-78, NSF funded OMEX, a small California firm in laser optics research, for $173,000. This led to the company's obtaining $8 million from a venture capital firm to pursue large-scale computer storage applications. More recently, the firm obtained an additional $3.7 million from a major title insurance company to produce full-scale hardware. If successful, the research may have made a significant contribution to the promising new field of large-capacity electronic filing and information storage.

Similarly, Terra Tek, Inc., a small Utah firm, was funded for research on measuring metal fracture toughness. The company went on to develop an instrument to measure the fracture toughness of mining and petroleum drill bit components. This instrument is now manufactured in the U.S. by Terra Tek and has sales world-wide. Terra Tek is now developing a full line of metal fracture toughness instruments for use in many other important fields where such measurements previously were not economically feasible.

Collaborative Research, Inc., a small Massachusetts firm, was funded in 1977 for genetic research to enhance animal protein production prior to the Supreme Court decision in this field. This research resulted in $11 million of follow-on investment from a major U.S. chemical firm, and led to a more recent highly successful public offering.

Objectives of the SBIR program are:

1. To increase the opportunity for small-science and high-technology firms to participate in NSF research.

2. To support quality research of interest to NSF with emphasis on areas that have potential application in industry.

3. To couple NSF research to follow-on private venture capital or other support to pursue commercial applications from the NSF-funded research project.

4. To increase technological innovation from Government-funded research and the resulting economic and social return on investment to the Nation.

The program represents a new approach to Federal research and development. It asks the question: "Does the research in NSF program areas also have commercial potential?" If it does, the program provides an incentive for the small firm to obtain a contigent commitment from a third party to provide Phase III follow-on funding to pursue commercial applications of the NSF research with private sector funds. Phase III is the product or process development phase.

Phase III funding is normally provided by venture capital or larger industrial firms interested in the technology and/or investment in the grantee firms. Because the commitment is made at the research stage, it is normally contingent upon the firm receiving a Phase II award from NSF and upon the success of Phase II research; that is, Phase II must achieve a few measurable technical objectives, that have been approved by the small firm and the third party, which are within the scope of the research proposed to NSF. This commitment is described more fully under "Follow-on Funding Commitment" on pages 65-66.

Venture capital and larger industrial firms that may have an interest in the research described or the SBIR grantee after reading the abstract are encouraged to contact the business offical of the SBIR firm whose name, address, and phone number are listed at the end of this publication.

Roland Tibbetts and Ritchie Coryell
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NSF SBIR Program, Room 1250
National Science Foundation
1800 G Street, N.W.
Washington, DC 20550
Telephone: (202) 357-7527

PHASE I AWARDS - 1981

TOPIC 1

MATERIALS RESEARCH

1. Fusion Casting of Refractories in a Centrifugal Plasma Furnace

Center for Innovation, Inc., P.O. Box 4050, Butte, MT 59702

Gerald E. Youngblood, Principal Investigator

NSF Grant No. DMR 81-14160 Amount: $29,786

The aim of this project is the development of a novel technique for producing quality fusion-cast refractories (ceramic oxides) in which total energy consumption can be reduced by addition of impurity fluxes. The total materials process and capital equipment costs may potentially be reduced when compared to present electric arc processes. The technique utilizes a Centrifugal Plasma Furnace, in which the heat source is a plasma created in an inert gas (or air). A cylindrical containment vessel rotates inside a water-cooled static vessel. The raw material can be fed continuously into one end, heated efficiently by the contained plasma, and the melt drained from the opposite end. The process could produce high-quality refractories since no fluxes are necessary. The atmosphere can easily be controlled. Thermal losses are reduced, heat time for the containment charge is relatively small, and the throughput can be high. This leads to a relatively small furnace per amount of material produced.

The potential commercial application as described by the awardee: Produce quality fusion-cast refractories to reduce total materials processing, total energy consumption, and capital costs.

* * * * * * *

2. Grain Boundary Phases in Structural Ceramics

Ceramic Finishing Company, P.O. Box 498, State College, PA 16801

Henry P. Kirchner, Principal Investigator

NSF Grant No. DMR 81-13284 Amount: $29,592.03

Polycrystalline ceramics are being considered as replacements for superalloys in high temperature structural applications in order to conserve critical materials and energy. Some of these ceramic bodies fail as a result of subcritical crack growth or creep by mechanisms that involve mainly the intergranular or grain boundary phase. In silicon nitride bodies containing MgO added as a sintering aid, the two most important mechanisms are cavitation and apparent diffusion in the siliceous intergranular phase. In this program, the grain boundaries will be simulated as joints formed between two pieces of the particular ceramic. The properties of the grain boundary phase will be evaluated as a function of temperature using single-edge notched beam or chevron notched beam tests. The compositions of the phases in the simulated grain boundaries will be varied to increase the crystallization, viscosity, or fracture energy of the material. The results for these materials will be compared with the results of similar measurements for compositions like those usually in the grain boundaries.

The potential commercial application as described by the awardee: If substantial improvements are observed, the new compositions will be used to make ceramic bodies. These will have potential commercial applications in the hot components of gas turbines, and also ceramic bearings.

* * * * * * * *

3. Fiber-Reinforced Microcracked Ceramics

Fiber Materials, Inc., Biddeford Industrial Park, Biddeford, ME 04005

James E. Sheehan, Principal Investigator

NSF Grant No. DMR 81-13781 Amount: $29,817

This research program is designed to obtain fundamental knowledge needed to assess the practicality of commercially producing fiber-reinforced microcracked ceramics. Microcracking can significantly increase the fracture toughness of ceramics but decreases their strength and elastic modulus. The strengths of glasses, cements, and other low modulus ceramics have been greatly improved by fiber reinforcement. Using high-density, refractory ceramic matrices in the microcracked condition, together with ceramic fibers, creates the potential for a new class of strong, tough ceramics. Benefits and opportunities include replacing metal alloys containing strategic elements, improving the reliability of ceramics in existing applications and accelerating the

development of certain materials-limited advanced systems. The study is based on reinforcing $MgTi_2O_5$-A_2TiO_5 matrices with A_2O_3 fibers. Specific research objectives are to identify processing parameters which result in high matrix densities and good fiber-matrix bonding, and to determine the effects of fiber reinforcement on strength, toughness, and the extent and orientation of microcracking.

The potential commercial application as described by the awardee: Immediate benefits would be the evolution of a new class of ceramics that could be substituted for metal alloys containing strategic elements and that would improve the reliability of ceramics in existing applications. Future benefits would be to accelerate development of advanced engines and large-scale energy systems and to identify new biomedical materials.

* * * * * * *

4. Chemical Vapor Deposition of Amorphous Silicon

Solarex Corporation, 1335 Piccard Drive, Rockville, MD 20850

Clement J. Moses, Principal Investigator

NSF Grant No. DMR 81-14221 Amount: $29,961

In order to lower energy consumption and material costs of fabricating semiconductor device structures, much work has been directed to replacing thick wafers of single crystal with thin layers of amorphous material. Although most work has concentrated on glow-discharge amorphous silicon, recent research has suggested that amorphous silicon prepared by the thermal dissociation of silane (Chemical Vapor Deposition, CVD) may have significant advantages. In particular, it has been found that CVD material is dense and well-linked, has stable electrical and optical properties, and can be controllably doped. This work is directed toward depositing thin films of CVD alpha-silicon and forming Schottky barriers on the films in order to investigate the potential of this material for device fabrication. Experience gained in this project could lead to a program involving doping studies and the fabrication of p-n and graded p-n junctions of CVD alpha-silicon.

The potential commercial application as described by the awardee: CVD amorphous silicon may have considerable potential as a low-cost replacement for single crystal silicon in semiconductor electro-optic devices.

* * * * * * *

5. Ion Beam Deposition of Cubic Boron Nitride as a Hard Coating from Borazine

Spire Corporation, Patriots Park, Bedford, MA 01730

Stanley M. Vernon, Principal Investigator

NSF Grant No. DMR 81-13365 Amount: $30,000

The research problem addressed is the synthesis by ion beam deposition of cubic boron nitride (BN), a compound normally formed only under high pressure. The objective of the research is: (1) to verify that a practical process for depositing hard, adherent cubic BN coatings from borazine can be developed, and (2) to develop the process for commercial use for hard-facing industrial cutting and turning tools. The anticipated result of the research is a practical method for hard-facing tools such as drill bits, lathe tools, and milling cutters. The longer life thus permitted by these coatings could result in lower costs of the products.

The potential commercial application as described by the awardee: The developed hard facing could be applied to cutting and turning tools to extend their useful life.

* * * * * * *

TOPIC 2

BIO-SOURCES OF MATERIALS

6. Production of Cellulose Powders Using Cellulase Enzymes

BioChem Technology, Inc., 66 Great Valley Parkway, Malvern, PA 19355

Dane W. Zabriskie, Principal Investigator

NSF Grant No. CPE 81-14122 Amount: $30,000

The objective of this project is to establish the technical feasibility of preparing cellulose powders using selective hydrolysis procedures catalyzed by cellulase enzymes. Cellulose powders are unique and versatile materials with food, pharmaceutical, and diverse industrial applications. The products derived from conventional acid hydrolysis processes are expensive, restricting their use

primarily to the manufacturing of pharmaceutical tablets, convenience foods, and other high value-added products. The application of cellulase enzyme technology offers an opportunity to produce cellulose powders less expensively and to improve their access to larger industrial markets. Powders with important new functional characteristics, owing to the selective hydrolytic activities, may also be produced. The research plan is designed to study the effects of the microbial source of the cellulase, the specific hydrolytic activities of the cellulase, the resource of the cellulose raw material, the physical properties of the cellulose raw material, and the duration of hydrolysis treatment on the cellulose powder products.

The potential commercial application as described by the awardee: New methods for producing existing cellulose products more economically can be developed, and cellulose powder products with new physical characteristics and functionalities can be introduced.

* * * * * * *

7. Electrocatalytic Reduction of Lignin to Phenolic Feedstocks

Covalent Associates, Box 3129, Saxonville Station, Framingham, MA 01701

Victor R. Koch, Principal Investigator

NSF Grant No. CPE 81-13687 Amount: $29,992

A need exists to identify and exploit alternative sources of organic raw materials for conversion into chemical feedstocks. The lignin component of woody biomass is such a source, and, being composed of methoxylated polyphenylpropane units, is amenable to electrochemical reduction to valuable phenolic compounds. By selectively complexing lithium ions with the carbon-oxygen bonds linking phenylpropane monomers, electron injection into such bonds is facilitated, thereby shifting the reduction potentials to more positive values. The objective of the research is to electrochemically reduce sulfite lignin, Klason lignin (from saccharification of woody biomass), and Kraft lignin (from black liquor) to phenolic feedstocks.

The potential commercial application as described by the awardee: A domestic source of useful phenolic compounds by selective depolymerization of lignin can be provided.

* * * * * * *

8. Chemicals from Salt-Loving (Halophilic) Microbes

Ecoenergetics, Inc., 408A Union Avenue, Fairfield, CA 94533

John R. Benemann, Principal Investigator

NSF Grant No. CPE 81-14233 Amount: $29,988

Salt-requiring bacteria contain as their principal lipid constituent an unusual compound: diphytanyl glycerol ether. This molecule allows the lipid membrane to exhibit rigid rather than fluid, properties useful under these extreme environmental conditions. The structure and molecular weight of the diphytanyl glycerol ethers suggest them as lubricants, but no information is available in the literature regarding their properties. Their content in halophilic bacteria is reported at 2.5 to 4 percent of dry weight (typically 3 percent). Under Phase I, this project has two specific objectives: to prepare sufficient lipid material from halophilic bacteria to allow product characterization, and to investigate the environmental conditions affecting product content. If a commercially promising material is identified, production process development can be carried out under Phase II. This project has the potential to use large salt evaporation ponds for chemicals production.

The potential commercial application as described by the awardee: Existing large salt ponds could be used for the production of halo-bacteria to provide new sources of lubricants, pigments, and other biomaterials.

* * * * * * *

9. In Vitro Production of Saltbush for Revegetation and Range Improvement

Plant Resources Institute, University Research Park, 360 Wakara Way, Salt Lake City, UT 84108

Cyrus McKell, Principal Investigator

NSF Grant No. PCM 81-13744 Amount: $29,999

Saltbushes of the genus Atriplex grow throughout the world. They are: (a) highly salt tolerant; (b) primarily perennial shrubs; and (c) important forage plants in arid zones of the world. The National Academy of Sciences has cited Atriplex as an underexploited plant in need of agronomic development. Because of

their normal habitat, the saltbushes are suitable for widespread introduction on marginally productive lands. Here, they could provide an acceptable return on investment without interfering with established crops. With a relatively high protein content combined with a high degree of palatability, these plants constitute an excellent forage crop. A technology that lends itself especially well to selecting desirable genetic characteristics is that of plant tissue culture. The proposed research will demonstrate the feasibility of using tissue culture to micropropagate plants from select stock of Atriplex canescens. The characteristic to be screened in Phase I will be salt tolerance. The results will lead to a larger scale project in Phase II, in which a population of genetically selected stock plants will be produced in vitro.

The potential commercial application as described by the awardee: Development of a successful in vitro culture system for saltbush will allow for the eventual production of uniform, high-quality plant materials for improving arid and semi-arid land productivity.

* * * * * * *

10. Antifungal Constituents of Rhamnus Prinoides

SISA Incorporated, 763-D Concord Avenue, Cambridge, MA 02138

Richard P. Duffley, Principal Investigator

NSF Grant No. PCM 81-13822 Amount: $29,435

Rhamnus prinoides, family Rhamnaceae, is a dicotyledonous angiospermic plant cultivated in Ethiopia and used in the preparation of local alcoholic beverages. The fruits of this plant are traditionally used in the treatment of fungal infection. A preliminary study conducted on this plant (T. Biftu, SINET, an Ethiopian J. of Science, Volume 2 (2), 1980) showed that the acetone soluble fraction of the methanol extract of this plant possesses antifungal properties against three dermatophytes: Microsporum gypseum, Mycrosporum ferrugenium, and Trichophyton schoenleinii. The proposed research will determine the activity of different solvent extracts of this plant. The biologically active fraction will be chromatographically separated into its components and each fraction will be bioassayed. The structure of active component(s) will be studied using spectroscopic and/or degradation methods.

The potential commercial application as described by the awardee: The developed antifungal agents could be used for treatment of ringworm, dandruff, athlete's foot, and similar infections.

* * * * * * *

TOPIC 4

ADVANCED MANUFACTURING PROCESSES

11. A Modeling Study of Abrasive-Waterjet Metals Cutting

Flow Technology Company, 21414 68th Avenue South, Kent, WA 98031

Mohamed Hashish, Principal Investigator

NSF Grant No. MEA 81-14500 Amount: $29,769

This project will theoretically and experimentally investigate a novel concept for metal cutting by means of high-velocity abrasive waterjets. The theoretical analysis will be concerned with developing a model of the abrasive-waterjet cutting phenomena to relate relevant parameters in a simplified formula. The relevant parameters include nozzle parameters (e.g., pressure and size), cutting parameters (e.g., traverse rate), abrasive parameters (e.g., type, particle size, and flow rate), and certain material properties that remain to be determined. The experimental investigation will provide a data matrix and qualitative observations that will aid in modeling the cutting process. Improved abrasive-waterjet nozzles will be conceptually designed based on the optimum combinations of flow parameters as determined from the experimental and theoretical investigation.

The potential commercial application as described by the awardee: An industrial abrasive-waterjet cutting tool capable of performing cutting operations more efficiently than present mechanical and flame cutters could be developed. Such a tool would cut metals, concrete, and other hard materials without the spoilage and other disadvantages associated with conventional tools.

* * * * * * *

12. Computer Control for Small-Hole Grinding

Hahn Associates, 26 Rice Avenue, Northboro, MA 01532

Robert S. Hahn, Principal Investigator

NSF Grant No. MEA 81-13282 Amount: $26,250

Production grinding of small holes, e.g., fuel injection nozzles, is seriously limited because of the low rigidity of the small diameter grinding wheels and their inability to round up stock runout and produce the stringent roundness, size, and concentricity required. The objective of this research is finding a method of rounding up small holes rapidly, thereby permitting much faster grinding cycles to be used with reduced costs. The method uses a microcomputer to control the slide motions of the grinding machine as well as the work rotation in response to grinding force signals received from load sensors in the wheelhead. As eccentric stock is encountered by the small grinding wheel, it will normally deflect and tend to follow the runout. With the computer control, these deflections of the wheel are eliminated, providing a much faster truing-up process.

The potential commercial application as described by the awardee: The performance of internal grinding machines can be improved to benefit users and manufacturers.

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13. Electromagnetic Transducers for Weld Inspection

Magnasonics Incorporated, 13108 Sandstone Place N.E., Albuquerque, NM 87111

George A. Alers, Principal Investigator

NSF Grant No. MEA 81-13691 Amount: $29,918

Welding is a very common method of joining steel parts, but it is often the mechanical weak link in the final products because the act of welding can introduce dangerous flaws. Thus, the load bearing quality of the entire structure depends upon the quality of the weld, and a detailed inspection of this region by some form of penetrating radiation is often demanded by law. With the introduction of automatic welding, this inspection process has become the rate limiting step, especially in the construction of new pipelines. Thus, there is a significant productivity increase available if rapid, automatic inspection of pipeline girth welds in the field can be made available. Ultrasonic inspection shows great promise for meeting this need, but the current systems are cumbersome and slow to install because a liquid couplant is needed between the transducer and the pipe wall. Electromagnetic transducers do not require a coupling fluid and are more amenable to high-speed inspection. Therefore, this research is directed at solving the few remaining problems of weld inspection by electromagnetic transducers.

The potential commercial application as described by the awardee: After increasing the speed and reliability of weld inspection of pipeline girth welds, the same technique could be applied to (1) welds on ships; (2) pipe fabrication mills where miles of welds must be monitored every day; and (3) welds in power plants and refineries where the joints must be able to endure adverse environments for long periods of time.

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14. Development and Identification of Operations Research Algorithms for Small Computers

Pritsker and Associates, Inc., P.O. Box 2413, West Lafayette, IN 47906

Joseph Polito, Principal Investigator

NSF Grant No. MEA 81-13841 Amount: $30,000

As desk-top computers find their way into the offices of more managers, the potential exists to provide easy-to-use operations research techniques for solutions of day-to-day problems. Such problems tend to be small and immediate and may not warrant the effort to use large computer operations research methods. Implementation of operations research on small computers must be storage-efficient, since the operations research code must coexist with the application program or the user interface. A candidate set of commonly used, powerful techniques with network structures has been selected. The set contains network optimization, distribution system design, PERT/CPM, Markov processes, discrete simulation, and a few others. The object of the research is to determine the feasibility of developing a unified network data structure that will support all of the operations research methods in a storage-efficient manner on a small computer. Also, algorithm developments needed to best utilize the data structure and the resources of the host computer will be identified.

The potential commercial application as described by the awardee: The developed algorithms could be applied to the software market for users of desk-top computers.

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15. The Thermastress Concept for Steel Reinforcing Wire Manufacture

U.S. Automation Company, 21836 Schmeman, Warren, MI 48089

Daniel J. Borodin, Principal Investigator

NSF Grant No. MEA 81-13681 Amount: $30,000

The Thermastress process is a "dieless drawing" approach to manufacturing low-carbon steel reinforcing wire (and other ferrous wire products). It obviates a wide range of inventory and processing hardware problems associated with conventional manufacturing and is especially useful for small-scale, multiple product processing at the district level. Moreover, it produces low-carbon steel wire of unusually high strength. The objectives of this research on the Thermastress process are: (a) determination of the fundamental relations between low-carbon steel rod structure and strain, strain rate, and temperature in 1000° to 2000°F (538° to 1093°C) range with emphasis placed on the interaction with the austenite transformation; (b) preliminary mechanical property evaluation of the materials generated in pursuit of objective (a); (c) coupling of the results of (a) and (b) to the process parameters of the low-speed Thermastress process and the resulting wire; and (d) assessment of the feasibility of the Thermastress process for application to mild steel wire manufacturing.

The potential commercial application as described by the awardee: The major application is to steel wire fabric reinforcement for concrete construction (annual world production of about 5 million tons), although other wire applications exist. Other applications include improved service center efficiency and materials savings from high strength-to-weight ratios.

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TOPIC 5

ADVANCED CHEMICAL PROCESSES

16. Hybrid-Phase Catalysts for the Oxidation of Phenol

Andrulis Research Corporation, 7315 Wisconsin Avenue, Bethesda, MD 20014

Edward M. Sweet, Principal Investigator

NSF Grant No. CPE 81-14085 Amount: $29,988

Hybrid phase bound metal-complex catalysts are being prepared, and their utility for the oxidation of phenol to p-benzoquinone is being investigated. Complexes containing vanadium, iron, cobalt, or copper are under study. Supports being used include polystyrene and silica gel functionalized with benzoate groups. The objective is an inexpensive route to produce p-benzoquinone and hyrdoquinone, which is widely used as an antioxidant and in photography.

The potential commercial application as described by the awardee: The proposed materials will provide an inexpensive means for production of p-benzoquinone and hydroquinone (used as an antioxidant and in photography).

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17. Electrochemical Production of Ozone

Castle Technology Corporation, 295 Mishawum Road, Woburn, MA 01801

J. Paul Pemsler, Principal Investigator

NSF Grant No. CPE 81-13348 Amount: $30,000

It has been known for many years that ozone can be produced by the electrolysis of strong acids cooled to temperatures well below 0 C, but the process is highly inefficient. A novel approach to the electrochemical generation of ozone at room temperature with energy requirements that may be as low as one-third of that required by the silent discharge process is being investigated. The new technology utilizes an oxygen-enhanced reaction at a porous anode. The program will allow demonstration of the approach and will assess the industrial potential of the new process. Success in cost reduction could open up major new areas and greatly expand the utilization of ozone by industry.

The potential commercial application as described by the awardee: Low-cost ozone produced by the new process would be used in large quantities in water disinfection, waste water management, pulp and paper industry, and other areas as a replacement for chlorine.

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18. Development of Non-Noble Metal Electrocatalysts

Electrochimica Corporation, 2485 Charleston Road, Mountain View, CA 94043

M. Eisenberg, G. Palumbo, K. Wong Sr., Principal Investigators

NSF Grant No. CPE 81-14483 Amount: $29,529

The possibility of developing non-stoichiometric oxo- and sulfo-spinel materials as non-noble catalysts for chemical and electrochemical processes (electrocatalysis) is to be examined. The stoichiometric imbalance often results in n-type or p-type semiconductor characteristics and appropriate specific catalytic effects, e.g., for cathodic or anodic electrochemical reactions. A new technique is used for screening catalyst materials. Two sulfospinel materials will be prepared in a quartz furnace and investigated. The potential significance of these novel catalysts for electrochemical or other chemical processes is considered.

The potential commercial application as described by the awardee: New catalyst and electrode materials will be developed.

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19. A New Class of Separating Agents

Merix Corporation, P.O. Box 67, Babson Park, MA 02157

Thomas W. Mix, Principal Investigator

NSF Grant No. CPE 81-14393 Amount: $30,000

Azeotropic and extractive distillation and extraction processes can offer high selectivities and low energy requirements, but are critically dependent upon the characteristics of the solvents used for their performance. Chlorofluorocarbons have lower solubilities than corresponding hydrocarbons for water and should therefore induce higher relative volatilities in azeotropic distillation where water is being driven overhead. The objective of this research is to demonstrate the feasibility and merit of chlorofluorinated separating agents for use in azeotropic and extractive distillation and in extraction. This is accomplished in two steps. First, commercially available Refrigerant 113 (trichlorotrifluoroethane) is contrasted with cyclohexane for dehydration of isopropanol by azeotropic distillation. Second, the feasibility and practicability of producing new chlorofluorinated separating agents are assessed.

The potential commercial application as described by the awardee: The processes can be used for the dehydration of alcohols, acetic acid, methyl ethyl ketone, and cellosolves; extraction of aromatics from refinery streams; separation of C4 olefins from C4 paraffins; separation of olefins from paraffins; acid gas removal; polymer processing solvent; extractive distillation; and hydrometallurgical liquid-liquid extraction.

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TOPIC 6

INDUSTRIAL BIOLOGICAL PROCESSES

20. Competitive Inhibitor-Enzyme Immunoassay

Bio-Metric Systems, Inc., Box 100, Navarre, MN 55392

Melvin J. Swanson, Principal Investigator

NSF Grant No. PCM 81-14073 Amount: $29,329

A research project is proposed to develop a novel type of enzyme immunoassay that has potential for meeting a need for fast, convenient, sensitive, and, for some applications, non-instrumental assays for many laboratory and non-laboratory applications. The components of the competitive inhibitor-enzyme immunoassay are a hapten-inhibitor conjugate and an antibody-enzyme conjugate. The antibody-enzyme conjugate will be prepared by photoaffinity coupling such that, when the hapten-inhibitor conjugate is bound to the antibody, the inhibitor will be bound to the enzyme. When the hapten is displaced from the antibody by analyte in the test sample, the competitive inhibitor can then be displaced from the enzyme by substrate. The enzyme will then be reactivated, giving a positive response to the presence of analyte. This enzyme immunoassay will be developed using penicillin for the hapten and analyte. The enzyme-inhibitor pair to be used first will be chymotrypsin with tryptophan methyl ester. An alternate enzyme-inhibitor pair will be acetylocholinesterase with p-amino-phenyl trimethylammonium bromide.

The potential commercial application as described by the awardee: A fast, convenient, non-instrumental assay for penicillin will be valuable for the dairy industry for detecting penicillin in milk resulting from treatment of cows for mastitis. There are many other potential commercial applications for the food industry, environmental monitoring, and medical applications.

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21. Acoustic Protein Separation

Bonneville Scientific, 391 G South Chipeta Way, Research Park, Salt Lake City, UT 84108

Allen R. Grahn, Principal Investigator

NSF Grant No. CPE 81-14007 Amount: $29,995

Biological macromolecules are of increasing importance to our society in medicine, industrial processes, and research. However, current separation methods for these macromolecules are either slow, complex, expensive, or lack discrimination. An innovative separation method is being developed in which the forces generated by ultrasonic radiation are utilized to concentrate and separate macromolecules. The main objective of this work is to demonstrate the feasibility of utilizing these forces to differentially concentrate one species of macromolecules in the presence of another in order to establish the basis for a simple, inexpensive, flow-through separator. The first stage of the research is devoted to demonstrating that the acoustic forces generated in an ultrasonic standing wave will cause macromolecules in solution to migrate to modal regions. The second stage of the work attempts to demonstrate the differential separation of two species in the same solution. Globular proteins are being used as the experimental model because most macromolecules which are of interest in a purified state are proteins.

The potential commercial application as described by the awardee: Methods of separation can be applied in human plasma fractionation and biochemical purifications (hormones, interferon, enzymes, etc.)

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22. The Optimization and Automation of Gene Synthesis

Collaborative Research, Inc., 128 Spring Street, Lexington, MA 02173

Bernadette L. Alford, Principal Investigator

NSF Grant No. PCM 81-14110 Amount: $29,983

At present there are no viable processes for the direct chemical synthesis of long-chain polynucleotides (>31 bases) or DNA molecules. Single stranded oligonucleotide blocks are chemically prepared first and then coupled enzymatically using T4 RNA ligase

or T4 DNA ligase. There are significant problems associated with this procedure in terms of yield, time required, separation of product and the prohibitive cost of the ligase enzymes. This proposal seeks to develop a new technique for gene synthesis based on the use of matriz-bound ligation enzymes. If successful, it will lead to an automated process for the synthesis of large polynucleotides or complete genes. Under Phase I, the ligation capabilities of T4 RNA ligase bound to a chromatographic matrix will be studied. Phase II would extend these studies to the actual synthesis of a gene, which will be cloned and expressed to produce a protein, such as urogastrone.

The potential commercial application as described by the awardee: An automative process to synthesize complete DNA genes, DNA fragments, and long-chain nucleotides can be developed.

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23. Antibiotics from Isopods

SISA Incorporated, 767-D Concord Avenue, Cambridge, MA 02138

Richard P. Duffley, Principal Investigator

NSF Grant No. PCM 81-13851 Amount: $29,603.02

The digestive tracts of certain isopods are sterile. Sterility is maintained by the secretion of an antibiotic substance. This material is active against a variety of bacteria, yet appears totally free of toxicity in rodents. The identity of this material has not yet been established. Using an antibacterial assay as a measure of activity, attempts will be made to develop the methodology for the isolation, accumulation, and identification of the bactericidal agent. The material will be fractionated by molecular size using gel filtration. If further purification is necessary, other chromatographic methods (ion-exchange and high performance liquid chromatography) will be employed. Additionally, antibody production will be attempted to develop an immunoassay as an independent assay and measure of purity. Purified bactericidal fractions will be studied using infra-red, ultraviolet, and nuclear magnetic resonance spectroscopy to determine as much as possible about the chemical classification of the material.

The potential commercial application as described by the awardee: The research could lead to the development of a novel class and source of antibiotics.

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TOPIC 7

MICROELECTRONICS

24. High-Throughput Line Source Electron-Beam Processing of Silicon-on-Insulator Structures for Microelectronics

Advanced Research and Applications Corporation (ARACOR), 1223 East Arques Avenue, Sunnyvale, CA 94086

Leslie J. Palkuti, Principal Investigator

NSF Grant No. ECS 81-14147 Amount: $29,510

Process technology for the high-throughput preparation of high-quality silicon-on-insulator (SOI) materials is being developed and evaluated. The technical approach involves the use of a precision line-source, shaped, continuous electron beam system. If successful in developing a process for the cost-effective production of SOI materials, many civilian and military electronic device applications will result. SOI materials also have potential solar cell applications. The line-source approach being pursued is unique compared to previously developed point sources for electron and laser beam annealing.

The potential commercial application as described by the awardee: This could result in the development of computer-controlled electron-beam systems for semiconductor material processing and the sale of high-quality silicon-on-insulator materials.

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25. Soft X-Ray Source for Microlithography

Mathematical Sciences Northwest, Inc., 2755 Northup Way, Bellevue, WA 98004

Edward A. Crawford, Principal Investigator

NSF Grant No. ECS 81-13840 Amount: $30,000

The miniaturization and speed of integrated circuits could be significantly improved by the development of a source of soft x-rays for photolithography applications. The company has developed a unique laser-generated, magnetically confined plasma plume which holds the promise of being an ideal soft x-ray source. Presently generated plumes of moderal z ions are at 100 eV temperatures, 10^{18} cm^{-3} densities, and last approximately 100

nsec. The addition of a simple z pinch, triggered by the plume itself, could compress the plume to 10^{19} cm^{-3} densities and 600 eV temperatures where it would be an extremely efficient generator of K or L shell x-rays in the 1-2 keV range. The efficiency and simplicity of such a device, plus the proven physics of the laser plume generation, hold great promise for commercial microlithography applications. The principal investigator is theoretically investigating the z pinch addition and its capabilities in the Phase I effort, using magnetohydrodynamic and atomic physics codes already developed for the laser plume modeling. An experiment is being designed, using primarily existing equipment, to prove out the commercial design in the Phase II effort.

The potential commercial application as described by the awardee: An efficient generator of soft x-rays can be incorporated into an industrial microlithography system.

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26. Transient Three-Dimensional Numerical Simulation of Microelectronic Semiconductor Devices

Scientific Research Associates, Inc., P.O. Box 498, Glastonbury, CT 06033

Harold L. Grubin, Principal Investigator

NSF Grant No. ECS 81-14389 Amount: $29,826

Numerical simulations used by the microelectronics industry have been invaluable in computer-aided design of circuits. However, the one-dimensional spatial variation allowed in most of the device simulations has limited application as minimum feature size of device dimensions go below a fraction of a micron. Two- and three-dimensional simulations are needed to properly account for the physics of device operation and to be used in advanced computer-aided design of circuits. The aim of this program is to implement the preliminary numerical code for a three-dimensional device simulation. In particular, a self-consistent solution of Poisson's equation, the continuity equation, and a simple external circuit are being obtained in which transport is represented by diffusion and drift. The code is being implemented in a manner that increased complexity can be included with minimal difficulty.

The potential commercial application as described by the awardee: Computer-aided design of semiconductor two- and multiterminal devices for VLSI and VHSIC applications can be developed.

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TOPIC 8

COMMUNICATIONS AND SYSTEMS

27. On-Line Tool Wear Estimation and Failure Prediction in Metal-Cutting Operations

ALPHATECH, Inc., 3 New England Executive Park, Burlington, MA 01803

Nils R. Sandell, Jr., Principal Investigator

NSF Grant No. ECS 81-13742 Amount: $29,777

This research investigates techniques for anticipating incipient failure of tools used in metal-cutting while the machine is in operation. The approach is to develop advanced, microprocessor-based algorithms to estimate cutting tool wear parameters on the basis of measurements made by suitable sensors monitoring the machine. Using these parameter estimates, the probability of catastrophic tool failure over a suitable time horizon is determined and reported as the machine operates, so that it can be stopped and the tool replaced before damage to the tool, the machine, or the workpiece occurs. Alternatively, tools excessively likely to break can be identified for replacement prior to the start of an operation. The research uses new results in nonlinear stochastic estimation theory, including dynamic hypothesis testing and generalized likelihood ratio tests. It requires development and verification of suitable dynamic stochastic models, selection of suitable sensors for use in a factory environment, design of algorithms, microprocessor implementation, and ultimately, system demonstration. Phase I addresses the initial stages of model development, sensor selection, and algorithm design which are necessary to demonstrate feasibility of the approach.

The potential commercial application as described by the awardee: Productivity could be improved and costs reduced in metal-cutting operations, viz., turning, drilling, milling, grinding, etc.

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28. Coding for Band-Limited Channels

Cyclotomics, Inc., 2120 Haste Street, Berkeley, CA 94704

Elwyn R. Berlekamp, Principal Investigator

NSF Grant No. ECS 81-14270 Amount: $30,000

This research project combines coding and digital modulation schemes to enhance reliability while attaining significant decreases in the amount of bandwidth used in communications and storage systems. The theoretical foundations of algebraic codes such as the Lee metric and of geometric codes such as those based upon Euclidean sphere packets are established and are promising approaches to pursue. However, these subjects have not yet progressed to the point where effective decoding algorithms are feasible to implement. Conservation of bandwidth rather than signal power through the use of error-correcting codes is emphasized. Anticipated results of this research include electronic devices to facilitate reliable communication and information storage with significantly less bandwidth. The techniques are helpful in reducing bandwidth requirement for satellite communication systems and permitting higher density magnetic recording.

The potential commercial application as described by the awardee: More bits per hertz in satellite communication systems and higher density magnetic recording can be achieved.

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29. Advanced Control of Electric Arc Furnaces

Scientific Systems, Inc., 54 Rindge Avenue Extension, Cambridge, MA 02140

Patrick B. Usoro and Raman K. Mehra, Principal Investigators

NSF Grant No. ECS 81-13878 Amount: $30,000

Although electric arc furnaces have been in existence since the turn of the century and the basic mechanism governing their operations is reasonably understood, adequate dynamic arc control of these systems to ensure efficient operation and minimize operating cost as well as production time has not been fully achieved. The difficulty with the dynamic arc control of the electric arc furnace is that the process is nonlinear, complex, and restricted by numerous operational and control constraints. In addition, variations in the arc furnace characteristics occur in the course of a melt cycle and also over time, due to wear, tear, and aging. These difficulties render conventional control techniques inadequate if the basic requirements for the efficient operation of the furnace are to be met. A robust, self-adjusting, digital Model Algorithmic Control (MAC) strategy acts in anticipation of system constraints, variations, and uncertainties to steer the operation of the electric arc furnace along an optimal path designed to yield

improved productivity. The research involves: (1) the development of a mathematical model which provides an accurate and physically realistic representation of a currently operating electric arc furnace, (2) the development of the control algorithm, and (3) evaluation of the control algorithm on the model system, during Phase I. Solving the dynamic arc control problem would result in energy savings and production cost reductions for the steel industry, and thus increase its profitability.

The potential commercial application as described by the awardee: The research would have direct application in the steel industry, as it is aimed at improving quality and reducing production cost and time. Hylsa, the largest Mexican steel company, may commercialize the proposed approach if it is demonstrated to be feasible and superior to current design.

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30. Feasibility Investigation for an Electrostatically Bonded Fiber Optic Coupler

Spire Corporation, Patriots Park, Bedford, MA 01730

Peter R. Younger, Principal Investigator

NSF Grant No. ECS 81-13366 Amount: $30,000

This research project deals with a demountable multichannel fiber optic coupler with fiber positioning precisely reproducible from coupler to coupler. The research objectives include (1) designing a ribbon-type coupler, (2) developing and evaluating the procedures for manufacturing the coupler, (3) developing the procedure for potting the coupler in a protective casing, and (4) developing a prototype fiber optic coupler as a commercial product. The anticipated result of the research is a new fiber optic coupler made available to the communications and/or process control industry, based on a multi-element, ribbon-type fiber optic cable. The cost of manufacturing the cable is reduced by the simple processing, involving electrostatic bonding, capable of assembling many fiber optic channels simultaneously. The lowered cost and simplified technology for coupler production extend the applicability of fiber optics. The fiber optic couplers are applicable in communication and data transmission systems and are particularly useful in control systems situated in harsh environments.

The potential commercial application as described by the awardee: Low-cost manufacturing of fiber optic couplers for communications and/or process control industry can be accomplished.

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31. Variable Structure Servomechanisms

Systems Engineering for Power, Inc. (SEPI), 226 Maple Avenue, West, Vienna, VA 22180

Lester H. Fink, Principal Investigator

NSF Grant No. ECS 81-13891 Amount: $29,853

High-performance feedback control systems which have a large degree of insensitivity to system operating conditions and process parameters are necessary for advancing the level of automation and improving the performance quality of manufacturing and other production processes. Variable structure (VS) feedback control systems, utilizing control laws which are discontinuous functions of system variables, and designed so that so-called sliding modes occur in the surface of discontinuity, can be made invariant to selected plant parameter variations and external disturbances. Such capabilities are especially important when the controlled system is subject to large, abrupt disturbances, must accommodate component failures, or must respond to emergency demands. This research addresses several remaining issues necessary for the implementation of VS controls. These include the treatment of modeling inaccuracies, in particular parasitic dynamics, leading to persistent chatter and the analysis of VS systems in the presence of stochastic disturbances.

The potential commercial application as described by the awardee: The VS control systems can be applied to electro-hydraulic actuators, power plant control, flight control systems, internal combustion engines, high-performance speed drives, machine tools, robots, electrical machines, etc.

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TOPIC 9

COMPUTER SCIENCE AND ENGINEERING

32. Array Processing of the Three-Dimensional Navier-Stokes Equations

Computational Mechanics Consultants, Inc., 3601A Chapman Highway, Knoxville, TN 37920

Paul D. Manhardt, Principal Investigator

NSF Grant No. ECS 81-14106 Amount: $29,429

The high cost of experimental fluid dynamics, combined with lower cost of computing, together with higher speed machines, has led to the continued growth and development of computational fluid dynamics (CFD). Summarily, the current capability of transonic CFD is three-dimensional, attached, steady, and fully turbulent flow. Programs at the current level of algorithmic development are straining the limits of linear programmed machines they are designed to run on. Array processors offer a means to significantly improve solution efficiency through simultaneous processing and pipelining. Efficient use of array processors, however, requires that the algorithm be closely tied to the hardware architecture. This introduces an additional non-linearity into CFM design, which alters previous conceptions of algorithmic preference. The purpose of the proposed project is to isolate the specific and distinct processes associated with space-split finite element algorithms, successfully applied to the solution of the Navier-Stokes equations, using conventional programming methods, and to re-evaluate them in light of array processor technology. This should result in significant improvement of algorithm timing, thus permitting the use of sufficient grid refinement to become a general tool to be used in fluid mechanics design processes.

The potential commercial application as described by the awardee: An analysis will be made of turbulent three-dimensional fluid dynamic systems in connection with vehicle aerodynamics, manufacturing processes, fuel system design, fluid flow processes, and turbo-machinery.

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33. Research into the Structure, Accessing, and Manipulation of Numeric Data Bases: Phase I

King Research, Inc., 6000 Executive Boulevard, Rockville, MD 20852

David M. Liston, Principal Investigator

NSF Grant No. IST 81-14042 Amount: $29,970

The general problem addressed by this research is the design of systems to facilitate the management and use of numeric data resources. Special emphasis is placed on assisting analysts who have data in hand to gain the kinds of intelligence about those data needed to draw solid conclusions. The research will seek to test, refine, and extend an emerging body of theory regarding the use of faceted classification to represent the nature of data elements and data instruments. This theory will be applied in

Phase I to the design of two distinct systems: a data system which gathers, stores, operates on, and provides access to numerical data; and a "metadata" system which classifies, indexes, stores, and provides access to information about those data. Phase II will involve the experimental implementation of these systems for the purpose of evaluating the theory and design methodology applied in Phase I.

The potential commercial application as described by the awardee: A model can be developed for the design of data systems in all segments of society. Data systems for supporting R&D, controling manufacturing or production, supporting financial control/administration/decisionmaking, and other management-oriented functions.

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34. Distributed Data Base Management on Local Networks

Relational Technology, Inc., 2855 Telegraph Street #515, Berkeley, CA 94704

Paul E. Butterworth, Principal Investigator

NSF Grant No. ECS 81-14274 Amount: $28,500

A research program on distributed data base management for local networks is proposed. The specific topics to be studied include: system architecture, communication environment, data allocation, query processing, concurrency control, and crash recovery. The proposed research represents the first phase in a program leading to a full implementation effort for systems that combine high performance, resilience, and distributed transparent user interface.

The potential commercial application as described by the awardee: The program will be used for office automation and data base management systems.

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35. Optical Image Analysis of VLSI Microcircuits

Tractell, Inc., 4490 Needmore Road, Dayton, OH 45424

Eugene E. Jones, Principal Investigator

NSF Grant No. ECS 81-13773 Amount: $27,645

Present microcircuit testing and analysis methods cannot be directly extended to future circuits in the VLSI/VHSIC arenas of the extreme design geometries and functional complexities. Therefore, this research presents and develops a radically new method to test VLSI/VHSIC circuits through the use of photographic images of liquid crystal coated (LCC) circuits. These images present new "data" on concurrent logical and electronic interactions of the circuit, and are expected to provide new methods of fault isolation and testing of microcircuits. In addition, LCC methods possess the capability to derive "time" and "space" measurements of circuit elements in response to a given software input. This capability suggests methods that might seek to optimize circuit space, time, and algorithm implementation. Moreover, this optimization could occur in advance of the irreversible circuit fabrication process, which is also very costly. From the implications of this research, the ultimate goal to create and optimize circuits of the future directly from LCC image data on current circuits seems quite possible. Thus, the key Phase I objectives of this research pertain to determining the feasibility of the LCC methods for circuit testing and analysis, and applying these findings to "area time" analysis of circuits.

The potential commercial application as described by the awardee: The developed method could be applied to automatic, functional testing of composite microcircuits at greatly reduced costs compared to present methods; circuit optimization using "area-time" analysis; and possible circuit designs directly from circuit images.

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TOPIC 10

ROBOTICS AND CONTROLS

36. Advanced Programmable Grey-Scale Vision for Robotics--Phase I

Automatix, Inc., 217 Middlesex Turnpike, Burlington, MA 01803

Pierre Trepagnier, Principal Investigator

NSF Grant No. ECS 81-14099 Amount: $30,000

Binary Machine Vision Techniques have shown to be useful for inspection and some aspects of robot control. However, the high contrast lighting required to obtain a silhouette image seriously limits the application of this technique to a small percentage of industrial situations. It is widely recognized that automated inspection and vision sensor-based robot control can have an

important impact on national productivity. However, for this potential to be fully realized, the restriction to binary imaging must be lifted. Such an extension will require the processing of grey-scale information instead of binary. Automatix has developed a proprietary micro programmable vision processor to implement binary vision algorithms for use in conjunction with Automatix's products. This highly flexible bipolar bit slice processor was designed to include grey-scale processing capabilities. In this research effort, the vision processing hardware is used as a test bed for research in grey-scale vision processing algorithms for robot control and inspection. The research investigates preprocessing algorithms developed for image processing along with statistical analysis algorithms and develops an experimental picture data base to test feasibility for industrial inspection and robot control.

The potential commercial application as described by the awardee: General purpose grey-scale vision can increase capability in both inspection and robot control.

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37. A Study of Robot Vision Techniques Using Acousto-Optic Image Sensors

Deft Laboratories, Inc., 7 Adler Drive, East Syracuse, NY 13057

Alan L. Moyer, Principal Investigator

NSF Grant No. ECS 81-13364 Amount: $28,542

This research program investigates robot vision techniques which utilize acousto-optic image sensors for the scene source data. More conventional image sensors provide, as output, the image intensity function. The output of acousto-optic image sensors is, rather, a two-dimensional integral transform of the image intensity function. Specific forms of this transform include the Fourier transform and image two-dimensional moments. These sensors prefilter the image and provide useful data which are expensive to compute digitally. This data can be the basis for robot vision and control algorithms with reduced digital processing requirements. Algorithms are identified, refined, and evaluated, and acousto-optic sensor performance parameters will be determined for these applications. These will be compared with current and projected sensor performance. This research is important and timely since, if digital processing could be reduced by sensor preprocessing, then much smaller and cheaper digital computers such as microprocessors might be adequate for robot control. The resulting system cost reduction would allow penetration of robotics into application areas where it is not presently cost-effective.

The potential commercial application as described by the awardee: Industrial robot vision systems and industrial parts inspection systems can be developed.

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38. Distance Sensor for Robotics

Kazuko Enterprises, Inc., 3475 Parkway Center Court, Orlando, FL 32804

Jack R. Minch, Principal Investigator

NSF Grant No. ECS 81-14506 Amount: $28,801

An important feedback element in robotics applied to various factory operations is precise determination of the position of the movable element. Gallium arsenide lasers have been used with sensitive receivers, a suitable reflector, and accurate distance-measuring techniques. Such time-of-flight measurement systems are limited when working over very short distances, are large because of optical apertures, and are relatively expensive. However, there has recently become available an entire new generation of solid-state laser or light-emitting-diode sources and detectors. The feasibility of selecting and incorporating these devices into a design suitable to determine distance accurately over ranges up to a few meters with a few millimeters resolution is the primary objective of this program. Preliminary design studies indicate the concept to be feasible, but reduction to a working breadboard is necessary to develop adequate data to validate the concept. Major goals include consideration of size, weight, cost, and reliability required to be cost-effective. Major efforts involved include design of a low-cost counter and a noise-immune receiver/video preamplifier, and achievement of acceptable system performance at short distances where the time of flight is in the sub-nanosecond region.

The potential commercial application as described by the awardee: Precise position detection at short ranges will be useful in automated warehouses, where materials are placed in or removed from bins, and the determination of critical "stop" distances.

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39. Servo for Industrial Robot with Force Control

Microbot, Inc., 453H Ravendale Drive, Mountainview, CA 94040

John W. Hill, Principal Investigator

NSF Grant No. ECS 81-13808 Amount: $29,990

Commercially available industrial robots have little or no ability to interact with their environment, as force-sensing and control means are not provided. This severely limits their application to industrial tasks and requires expensive, special purpose jigs and fixtures. The objective of this research is the development of a multimode robot servo with force-sensing and control modes in addition to the usual position modes. Implementation is based on a microcomputer-controlled, low-cost motor and position sensor. When used on an industrial robot arm, this drive package will permit the arm to sense its environment (proprioceptive sensing); exert controlled forces and torques on it; or to exhibit programmed compliant behavior in response to external forces. The lower cost and increased capability of this approach will extend the application of robots (large and small) in batch manufacturing and assembly tasks.

The potential commercial application as described by the awardee: The research may be used in robot applications where force interaction is an important part of the task--batch assembly, loading/unloading production machinery such as presses, injection moulding machines, and machine tools.

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40. Robotic Camera Improvements

Optra, Inc., 1727 Revere Beach Parkway, Everett, MA 02149

Michael Hercher, Principal Investigator

NSF Grant No. ECS 81-14121 Amount: $29,512

This research demonstrates the feasibility of a TV camera with great improvements in dynamic range as well as antiblooming and blemish insensitivity. The key concept is "predetection unsharp masking," which allows imaging only those regions of the image where sharp spatial gradients occur. A uniform pedestal level is effectively ignored, so dynamic range is increased. Because of the difference between a focused image and a slightly defocused

image (this is what "unsharp masking" means), local variations in sensitivity (blemishes) tend to cancel. These improvements are now possible because of a new multichannel spatial light modulator being developed at MIT.

The potential commercial application as described by the awardee: A camera such as the one proposed would have many applications beyond robotics, such as bank surveillance, where the same scene may contain very bright and very dark regions. A camera such as this can handle this type of situation.

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TOPIC 11

SCIENTIFIC AND INDUSTRIAL MEASUREMENTS

41. Compton Backscatter Computed Tomography

Advanced Research and Applications Corporation, 1223 East Arques Avenue, Sunnyvale, CA 94086

James H. Stanley, Principal Investigator

NSF Grant No. DMR 81-13807 Amount: $29,734

Computed tomography (CT) is a radiographic method of determining point-by-point density values in thin cross sections of an object from a large number of systematic x-ray transmission measurements. Typically, only a very small fraction of the incident photon flux is transmitted during conventional CT examination of an object. The majority of the x-rays are removed from the incident beam by absorption or scatter. A new 3-D imaging technique which relies upon measurements of the Compton scattered radiation is planned, and has been designated Compton backscatter CT to distinguish it from conventional transmission CT. The method utilizes a monoenergetic isotopic x-ray source to scan the object under examination and a high-resolution energy-sensitive detector mounted on the same side of the object to measure the Compton scattered radiation. Since the approach transmits and detects the signal from the side of the object, it offers many of the advantages of ultrasonic techniques; specifically, compactness, portability, and compatibility with in-service or in-process inspection; but because it is a CT x-ray technique, it is indifferent to excessive object granularity or surface irregularities and can provide a quantitative 3-D image of the object, thus allowing the examiner to accurately detect, locate, and size subsurface structure.

The potential commercial application as described by the awardee: Imaging problems, such as large rocket motor inspection within the aerospace industry and critical piping components within the nuclear power industry, would be amenable to the proposed back-scatter approach.

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42. Scanning Spectral Correlator

Aerodyne Research, Inc., Bedford Research Park, Crosby Drive, Bedford, MA 01730

H. John Caulfield, Principal Investigator

NSF Grant No. DMR 81-14251 Amount: $30,000

Four normally conflicting goals can be achieved in a single apparatus according to the concept described in this project. Those goals are high spatial resolution, high spectral resolution, high throughput (spatial picture elements per unit time), and low cost. An apparatus having such a combination of properties would be very useful for inspection of objects, e.g., semiconductor devices, for various types of contaminants. The basic idea is to use holographic spectral correlator with independent channels (one per contaminant or one per "color") in parallel with a single detector for each scene "component" (contaminant, color, etc.). Simple mechanical scanning of the point of interest across the object achieves spectral classification at high spatial resolution in a means which involves spectral multiplexing (and hence can be high speed). The basic concept was developed by Caulfield (1) several years ago, but no proof-of-principle funds have been available for a demonstration.

The potential commercial application as described by the awardee: The research could provide a fast, inexpensive way to map contaminants on surfaces which would be of particular value in the semiconductor industry.

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43. Increasing Latent Fingerprint Fluorescence by Means of an Acousto-Optic Output Coupled (Cavity-Dumped) Variable Pulse Width Argon-Ion Laser

ALM, Inc., 1745 South Jefferson Davis Highway, Suite 900, Arlington, VA 22202

William F. Frizzel, Principal Investigator

NSF Grant No. DMR 81-14154 Amount: $29,581

The work effort relates to improvement in the techniques of latent fingerprint detection by means of an argon-ion laser. The specific improvement is the greatly increased latent fingerprint fluorescence which occurs when various constituents of palmar sweat compounds, among which are amino acids, lipids, vitamins, riboflavin, and pyridoxin, are exposed to high peak power pulses from an acousto-optic coupled (cavity-dumped) variable pulse width argon-ion laser. The approach is to illuminate, by means of argon-ion laser pulses exceeding 500 watts, control latent fingerprints, and measure qualitatively and quantitatively the resultant luminescence and fluorescence of such fingerprints. The use of an acousto-optic output coupler (cavity dumper) in conjunction with an argon-ion laser and associated electronics permits convenient control over such key variables as pulse width, intra-cavity coupling factors, and repetition rates. Laser pulses of high peak power and low average power densities are then generated to illuminate the control latent fingerprints. Subsequent filtering, measurements of fluorescence intensity, and photographic analysis can then be compared with conventional continuous wave (CW) latent fingerprint detection methods. It is anticipated that greatly increased luminescence and fluorescence of palmar sweat constituents will result in detection of latent fingerprints upon a wide variety of evidence materials and substrates which would not be detectable using current continuous wave (CW) argon-ion laser detection techniques. The incorporation of an acousto-optic output coupler (cavity dumper) to existing laser latent fingerprint detection systems should prove to be a valuable tool for greatly enhancing the capabilities of forensic scientists involved in the detection of latent fingerprints by means of laser excitation.

The potential commercial application as described by the awardee: The use of an acousto-optic output coupler in conjunction with an argon-ion laser will be a unique tool for enhancing the capabilities of law enforcement officials involved in the detection of latent fingerprints.

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44. An Advanced Detection System for Quantitative Three-Dimensional Ion Microscopy

Charles Evans and Associates, 1670 South Amphlett Boulevard, Suite 120, San Mateo, CA 94402

Bruce K. Furman, Principal Investigator

NSF Grant No. DMR 81-13779 Amount: $30,000

The growing demand for an improved understanding of materials phenomena has fostered the development of advanced instrumentation, particularly for microanalytical characterization of materials. These include the Auger electron microprobe, laser microprobe mass spectrometer, and secondary ion microscopy, the latter being the focal point of this proposal. The most recent generation of the ion microscope, the Cameca Instruments IMS-3f, provides for imaging of the lateral distribution of elements and impurities with detection limits in the ppm and ppb regime, 0.3 micrometer of lateral resolution and 10 to 100 Å resolution in depth. The goals of this research project are to investigate the feasibility of developing an advanced imaging system consisting of new detector hardware interfaced to a computer system with appropriate software which will allow for the generation of three-dimensional ion images displaying the lateral and in-depth distribution of impurities.

The potential commercial application as described by the awardee: Development of semiconductor materials, biological systems, and materials of metallurgical and ceramic interests. Research in this area could lead to an advanced instrumentation package of significant value to users of ion microscopy and other microanalytical techniques, and the benefits to materials research would be of great value to technological advancement.

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45. A Laser-Based Photoacoustic Method for Measuring Stable Isotope Ratios

KOR, Inc., 56 Rogers Street, Cambridge, MA 02142

Fraser M. Walsh, Principal Investigator

NSF Grant No. DMR 81-14005 Amount: $29,976

The program relates to the use of a laser-based photoacoustic spectrometer in the measurement of stable isotope ratios ($^{13}CO_2/^{12}CO_2$). The major objective of the program is to demonstrate that a photoacoustic spectrometer, which uses a new laser design of a single power supply with two tubes filled with either $^{13}CO_2$ or $^{12}CO_2$ and two spectophones in series, can provide precision and accuracy at least equal to a mass spectrometer in the measurement of stable isotope ratios (min. of ±0.001‰). The major advantages of the photoacoustic spectrometer method are: high theoretical precision and accuracy, speed in analysis, operator ease, low cost, and lack of instrumental sophistication requiring a skilled operator. The program approach is to make and test a CO_2-laser-based photoacoustic spectrometer using information from the domestic and foreign literature, from KOR's experience with lasers, and from the experience of the consultant experts; the system will be evaluated using gas mixtures and human breath. The unique properties of a laser-based photoacoustic spectrometer should provide a new analytical instrument with sensitivity equal to a mass spectrometer but capable of measuring directly isotope ratios not accurately measurable by a mass spectrometer. The new instrument should be avilable at a price five times less than a comparable mass spectrometer. An instrument of this type would have immediate application in the areas of health maintenance, medical diagnosis, exploratory geology, physical chemistry, and analytical chemistry.

The potential commercial application as described by the awardee: A laser-based photoacoustic spectrometer as described in this proposal could be profitably sold for approximately $25,000. Immediate commercial applications of this instrument include analysis of breath samples for non-invasive outpatient screening or diagnosis for common metabolic diseases, and analysis of combustion or gas samples in exploratory geology.

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46. Quantum Ferroelectric Pressure Sensor

Lake Shore Cryotronics, Inc., 64 E. Walnut Street, Westerville, OH 43081

W.N. Lawless, Principal Investigator

NSF Grant No. DMR 81-13317 Amount: $30,000

The project deals with investigating the quantum limit in the ferroelectrics $Cd_2Nb_2O_7$ and $Sr_2Ta_2O_7$ using Pb and Ba substitutions, respectively, to lower the transition temperature into the critical

$T_c \longrightarrow 0°K$ regime. Ceramic samples are proposed which will be structurally characterized by x-ray diffraction. Dielectric data ($1 \longrightarrow 200K$) will be used to evaluate critical exponents and to compare with mode-coupling theories. The dielectric data will also directly establish the technical feasibility of a capacitive pressure sensor below $\sim$ 10K which would be a temperature-independent, magnetic-field insensitive, linear, solid-state device.

The potential commercial application as described by the awardee: Develop a small, solid-state device for the accurate measurement of pressure below 10K and up to 30 kbar can be produced for use in superconducting apparatus and in research instrumentation.

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47. Photon-Induced Surface Conductivity Requiring the Presence of Sorbed Photoionizable Species

Quantatec International, Inc., 9773 Variel Avenue, Chatsworth, CA 91311

Robert A. Young, Principal Investigator

NSF Grant No. DMR 81-14108 Amount: $30,000

Preliminary measurements have shown that a photoinduced surface conductivity occurs on MgF_2 (a vacuum ultraviolet window material) and Pyrex glass. This conductivity is proportional to the concentration of benzene (ionizable by the 123.6nm radiation used) below 10 parts per billion and roughly independent of the concentration above this concentration. This is a new phenomenon. The size of the surface currents are such that measurement of benzene at the parts per trillion level is feasible. These measurements were made in a device which places a cylindrical ionization region inside a very efficient RF plasma source of ionizing radiation. The electrode used to collect ions produced in the volume or currents on the surface are physically and electrically separate from those used to create the plasma. This device has at least 100 times the sensitivity of current commercial instruments using volume photoionization. Using the photoinduced surface conductivity, an instrument having a sensitivity 10^5 times that now available may be possible. No data have been taken in a liquid media. Direct application to gas and liquid micro-chromatography is possible and could revolutionize these instruments by increasing their sensitivity and decreasing their sensing volume. Quantatec will study the surface conductivity phenomena in both gas and liquids using several wavelengths of ionizing radiation, several electrode configurations, several materials including glasses,

crystals, plastics, and epoxies, and several ionizable species at several temperatures. A theoretical analysis of this data will be made in terms of physical processes causing the surface conductivity. Direct comparison with existing chromatographic detectors will be made using typical chromatographs and input samples.

The potential commercial application as described by the awardee: A new geometric configuration of the VUV light source, in conjunction with ion collection and surface current measuring electrodes, is demonstrated to be an improvement of more than a factor of 100 on present photoionization gas chromatography detectors. The photoinduced surface conductivity phenomena will be at least 1,000 times more sensitive and may be used as a detector on high performance liquid chromatography.

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48. Eddy Current Imaging

Spectron Development Laboratories, Inc., 3303 Harbor Boulevard, Suite G-3, Costa Mesa, CA 92626

B.P. Hildebrand, Principal Investigator

NSF Grant No. DMR 81-13820 Amount: $30,000

Eddy current, or electromagnetic nondestructive testing methods, are rapidly becoming an accepted means for determining the integrity of materials and certain structures such as tubing. The main operational functions common to most electromagnetic tests are (a) the excitation of one or more test coils to produce an electromagnetic field within the test object, (b) the modulation of the electromagnetic field quantities by the test object, (b) the modulation of the electromagnetic field quantities by the test object, (c) the preparation of the test coil output signals for analysis, (d) the analysis of the processed signals, and (e) the display or indication of the analysis. Items (c), (d), and (e) are addressed in this project. Currently, the results are displayed on chart recorders or oscilloscopes in a manner which requires specialized knowledge of the operator for interpretation. That is, the display does not have a one-to-one relationship to the object under test. It is planned that the signals be processed and displayed so as to indicate the size, shape, and position of the defect in relation to the boundaries of the object.

The potential commercial application as described by the awardee: This research could lead to more useful eddy current inspection systems capable of displaying defects in their correct 3-D relationship. Many inspection problems would benefit from such a new instrument.

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TOPIC 12

RADIATION PROCESSING AND CONTROL

49. Microanalysis Methods for Inhomogeneous Materials

Advanced Fuel Research, Inc., 87 Church Street, East Hartford, CT 06108

David G. Hamblen, Principal Investigator

NSF Grant No. PHY 81-13867 Amount: $29,994.69

This program will develop new automated procedures using the scanning-electron microprobe for analyzing inhomogeneous materials such as coal and ores. The proposed procedures are an extension of previous work which developed methods for determining concentrations of sulfur and major minerals in coal. The microprobe will be used to determine the spatial distribution of the elements so that the organic sulfur (uniform distributions of sulfur) can be distinguished from the mineral sulfur (clustered distributions of sulfur correlated with a clustered distribution of iron). The spatial distribution of other major minerals (Al, Si, Ca, K) will be determined so that the sulfide measurement can be corrected for the presence of iron oxide or calcium sulfate. For making the above determinations, the microprobe obtains elemental compositions of a large number of subsamples, where a subsample can be an individual coal particle. The data on chemical composition of particles will be used to predict the beneficiation potential of coals and ores. From the elemental composition of the individual particles, physical properties such as density and magnet moment will be determined. From this information, both the quantity of separated fractions and the composition of the fractions can be predicted. The information will permit the assessment of the effectiveness of density separations, magnetic separation, or froth flotation for a candidate coal or ore and suggest particle size for optimum cleaning.

The potential commercial application as described by the awardee: A commercial instrument could be developed to perform quantitative analyses of ores and coals on line to monitor changes in feedstock and direct process streams.

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50. High Current Ion Implantation

Mission Research Corporation, 1400 San Mateo Boulevard, S.E., Suite A, Albuquerque, NM 87117

Richard J. Adler, Principal Investigator

NSF Grant No. PHY 81-14287 Amount: $29,772

Recent research in ion implantation in metals indicates that implantation can result in significant, beneficial changes in surface properties. This grant will support development of a high current implanter for industrial applications. The approach utilizes the production of intense short pulses of ions at a high repetition rate. Recent advances, both in single pulse production of heavy ions and at a high repetition rate pulsed power indicate that this is a promising method of generating very high average current beams. Both high electrical efficiency and a wide choice of ions should be available using this technique. Two principal goals of the research are: theoretical demonstration of a method of enhancing ion current density and experiments on materials for the heavy ion source. External injection of electrons is expected to result in enhanced ion current densities and in extending the applicability of ion diodes to very low energies. The surface flashover plasma source has, in the past, proven to be versatile and its use will be evaluated. The high current, pulsed power approach to ion beam generation is anticipated to be much simpler and less expensive than present technology.

The potential commercial application as described by the awardee: Apply high current implantation to machinery in which reductions in wear, fatigue, corrosion, or friction will result in significant economic advantages. In particular, wear and corrosion can be reduced in critical parts where replacement is expensive. The suggested implanter will facilitate application of these techniques in industry.

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51. Spatial Resolution in Industrial Tomography

Scientific Measurement Systems, Inc., Suite 303, 3808 Longhorn Boulevard, Austin, TX 78759

Ira Lon Morgon, Principal Investigator

NSF Grant No. PHY 81-14001 Amount: $29,966

Computerized tomography has found wide applications in the field of medical diagnostics. Along with its success in the medical fields, it has found significant attention in industry as a tool for assessment of various systems. In many industrial situations, mere visibility of the interior of the object does not suffice; rather often the interest is focused on obtaining accurate and detailed information on such parameters as the physical extent of the defects or anomalies contained in the object. As far as industrial application of tomography is concerned, the question of spatial resolution has received only some preliminary theoretical consideration. It is proposed to conduct a detailed parametric study of spatial resolution as a function of relevant systems and object parameters. A high-energy laboratory tomograph will be used to examine in detail a specially-fabricated sample--a phantom--which will be constructed to span a significant range of object parameters commonly encountered in the industry. The system parameters, such as source characteristics, detector collimations, exposure times and relevant computer algorithms, are essential parameters contributing to spatial resolutions. A judicious selection of these will be made to obtain information on the parametric dependence of the spatial resolution obtainable.

The potential commercial application as described by the awardee: This study is expected to provide valuable guidelines in obtaining specifications for the construction of tomographic field and/or laboratory devices possessing a high degree of spatial resolution and in foreseeing the application in many areas, such as the petrochemical industry, detection and assessments of cracks and/or defects in weld joints, and assessment of earthquake damage.

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TOPIC 13

LIGHT MACHINERY AND COMPONENTS

52. The Direct Action of Electromagnetic Fields on Fluids

Eagle Engineering, Inc., 85 Crofut Street, Pittsfield, MA 01201

Sanborn F. Philp, Principal Investigator

NSF Grant No. MEA 81-13794 Amount: $30,000

The proposed research investigates the feasibility of using electric and magnetic fields directly for pumping non-conducting fluids. The principal elements in the proposed work are: (1) determination of the magnitude of attainable fluid pressures; (2) identification of fundamental limitations arising from fluid properties, such as dielectric properties, insulating strength, and high-frequency absorption; (3) computation of attainable efficiencies in pumping; and (4) experimental demonstration of the concept for both the charge injection and the electrostrictive concepts.

The potential commercial application as described by the awardee: The proposed research can be used for fluid pumping and fluidic controls.

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53. Research on Improved Dynamic Torque Control of Standard Induction Motors

IMEC Corporation, 93 Massachusetts Avenue, Boston, MA 02115

Donald E. Fulton, Principal Investigator

NSF Grant No. MEA 81-14257 Amount: $30,000

The goal of the proposed research is to improve the dynamic response of controllers for standard induction motors so that they are a viable alternative to the DC motor in high performance applications. A controlled current/slip type of motor controller has been shown to be capable of achieving good dynamic torque response from standard induction motors. However, good performance requires the controller to be quite closely matched to the motor. The technical approach taken here is to modify the control laws of a controlled current/slip controller so that the controller

can sense the key motor parameters and adapt or match itself to the motor. The first adaptive approach involves adding feedback paths to a controlled current/slip controller such that the controller can update itself on motor parameters while the motor operates. The second approach utilizes a simple test signal that can be used to probe an induction motor electrically during a short rest interval between operating cycles.

The potential commercial application as described by the awardee: A motor/actuator for high-performance servo-applications, especially in hostile environments, can be developed. It also can be used to improve performance of machine tools and light machinery and in the replacement of DC motors.

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54. Bearing Structures Fabricated from Arc Plasma Sprayed Layers Coated with Solid Film Lubricants

Solamat, Inc., 885 Waterman Avenue, East Providence, RI 02914

Barton Roessler, Principal Investigator

NSF Grant No. MEA 81-14267 Amount: $30,000

This research is concerned with the fabrication of multilayer bearing structures. High-strength, load-bearing layers are deposited on steel by Arc Plasma Spraying (APS) and these layers are coated with a dry thin film solid lubricant containing MoS2 and graphite in an epoxy liquid. The thickness of APS layers of tungsten carbide and of self-fluxing nickel-chromium-boron alloys is adjusted to sustain high loads, and the surface morphologies are selected to provide enhanced adhesion of a thin layer of a dry film solid lubricant called Molylube. The bearings are tested on Falex and Timkin bearing test equipment. Fabrication and test procedures are established using these results.

The potential commercial application as described by the awardee: High-load, long-life, quiet bearings requiring no liquid lubricants can be developed.

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55. Self-Feeding Fluid-Film Bearing

Shaker Research Corporation, Northway 10 Executive Park, Ballston Lake, NY 12019

C.H.T. Pan, Principal Investigator

NSF Grant No. MEA 81-13899 Amount: $28,980

This research is concerned with the analysis of a retention-supply-sealing system for fluid film bearings. The functions of storage and wicking of porous media are supplemented by the concept of induced suction flow to extract lubricant contained in a porous reservoir. The specific objectives of the first phase of research are: (1) determination of D'arcy coefficients and porosity factor of various materials for the porous washer; and (2) development of analytical means to predict sliding-induced suction flow rate.

The potential commercial application as described by the awardee: The system could be used in the development of rotating disc drive spindles; fans, blowers, and pumps; machine tools; robotic components; household appliances; and environmental control equipment.

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TOPIC 14

ADVANCED AUTOMATIVE RESEARCH

56. The Application of Resilient Bearings to a Crankshaft of a Diesel Engine

Cambridge Collaborative, Inc., 169 Bent Street, P.O. Box 74, Cambridge, MA 02142

Natan Parsons, Principal Investigator

NSF Grant No. MEA 81-14081 Amount: $29,862.20

It is well-documented that diesel engines are inherently noisy devices. The noise generation mechanisms can be defined under three categories: exhaust noise, intake noise, and mechanical noise. Techniques to supress intake and exhaust noise have been well-developed, and the results are satisfactory. In general, the

dominant mechanical noise sources in a diesel engine are combustion, piston slap, unit injectors (if used), and gear mesh. Whatever the excitation source, the vibrational energy it creates is transmitted through various transmission paths to the external radiating surfaces. In most cases, the major transmission path is through the crankshaft. If isolation of this path can be achieved, a substantial reduction in overall noise level can be expected. The research investigates isolation by mounting the crankshaft in a set of resilient bearings. The bearing is of sandwich construction with teflon as the interior material. The influence of this type of resilient bearing on wear of the bearing surface and the fatigue stress of the crankshaft is being determined.

The potential commercial application as described by the awardee: Resilient bearings can be applied to crankshafts of diesel engines.

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57. Deuterated Additives for Automotive Lubricants

KOR, Inc., 56 Rogers Street, Cambridge, MA 02142

Alfred M. Ajami, Jr., Principal Investigator

NSF Grant No. CPE 81-14024 Amount: $28,203

The proposed work relates to improvements in automotive lubricant additives, specifically the replacement of the hydrogen in the additive's structure with deuterium. The approach is to prepare, by direct total synthesis, deuterated zinc dialkyldithiophosphate (ZDTP) and to measure the oxidation rates of thin films of synthetic hydrocarbon base oil containing ZDTP on steel surfaces at high temperatures in the presence of dry air. It is anticipated that the total life of the oil will be prolonged by the use of deuterated ZDTP. Comparisons will be made between deuterated and undeuterated ZDTP. It is anticipated that deuterated ZDTP will prove a superior additive for automotive lubricants and transmission fluids.

The potential commercial application as described by the awardee: Deuterated ZDTP can be used to replace ZDTP as an oil additive.

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58. Studies of Woven Fabric Reinforced Composites for Automotive Applications

Materials Sciences Corporation, Blue Bell Office Campus, Merion Towle House, Blue Bell, PA 19422

Norris F. Dow, Principal Investigator

NSF Grant No. DMR 81-13749 Amount: $30,000

This research program will evaluate and improve woven fabrics for reinforcements for composite materials used in automotive applications. Woven fabrics appear to offer potentials of combined performance and ease of fabrication, which have neither been explored nor exploited. The key problem is the identification and quantification of the role played by the crimp of the fabric in woven constructions in providing formability with minimum loss in reinforcement capabilities. The research is directed toward: (1) the characterization of this role both by experiment and analyses; (2) the evaluation of the potential of woven fabrics properly designed according to these analyses for automotive applications; and (3) the development of guidelines for, and fabrics utilizing, such designs. The development of these fabrics should lead to substantial economies both in manufacture and use throughout the automotive industry.

The potential commercial application as described by the awardee: Woven fabric reinforcements for composites offer cost-effective weight savings for automotive applications.

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TOPIC 15

FOOD PROCESS ENGINEERING

59. Investigation of the Effect of Processing Techniques on the Reduction of Cholesterol and Lipids in Muscle Foods

Webb Foodlab, Inc., 3309 Drake Circle, Raleigh, NC 27607

Neil B. Webb, Principal Investigator

NSF Grant No. CPE 81-14394 Amount: $29,426

This research is a feasibility study of the effect of processing techniques on the reduction of cholesterol and lipids in muscle foods. This study will examine various pre-treatment and cooking processes with the objective of reducing lipids and cholesterol without substantially changing the inherent nutritional value of muscle proteins.

The potential commercial application as described by the awardee: The results will have applications throughout the food industry through alterations in processing techniques, dietary needs, and resource utilization.

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TOPIC 16

MARINE RESOURCES

60. A Feasibility Experiment in Stabilizing Canadian Mussel Seed Transplanted into New England Waters

Abandoned Farm, Inc., Box 551, Damariscotta, ME 04543

Edward A. Myers, Principal Investigator

NSF Grant No. OCE 81-14158 Amount: $29,610

Mussel farmers now rely upon the natural settlement of mussel larvae on substrates introduced into waters leased under Maine's aquaculture law of 1973. A supply of mussel seed sets is needed to guarantee a quality, reliable, mass-produced supply of mature mussels for identifiable marketing opportunities. Until such supplies are available, this infant industry will not develop. A 6-month Phase I experiment will allow comparison between an initial batch of Canadian (Prince Edward Island) seed against an indigenous control batch as to survival rates, growth patterns, and other commercial attributes. Bioenvironment measurements can be made, and management adjustments can be identified that might overcome any problems in stabilizing the Canadian seed. Costs will be carefully monitored.

The potential commercial application as described by the awardee: Canadian seed sets could be implemented for commercial purposes and industry developed if rate of return is in line with current returns.

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61. Cage Culture of Red Tilapia in Prawn and Shrimp Ponds

Aquatic Farms, 49-139 Kamehameha Highway, Kaneohe, HI 96744

Frank Meriwether, Wayne Yuk Okamura, Principal Investigators

NSF Grant No. OCE 81-13719 Amount: $29,969

Male fingerlings (first generation) of the red strain of the hybrid cross Tilapia nilotica (female) X T. mossambica (male) (the "Taiwan hybrid" or the "red nilotica") will be produced and grown to market size in floating cages suspended in shrimp and prawn production ponds. Growth rates and feed conversion rates using two commercially available diets will be calculated for Tilapia grown in the freshwater (prawn) and saltwater (shrimp) ponds. Effects of Tilapia culture on prawn and shrimp pond water quality, production, and plankton species composition will be determined. The effect of high salinity on the reproductive success in this Tilapia strain will be observed. Specific recommendations will be given leading to optimal pond production using the polyculture techniques developed in the study.

The potential commercial application as described by the awardee: Net economic returns to prawn and shrimp farmers could increase dramatically with the use of techniques and data obtained from this study. More efficient utilization of available pond space and improved quality of pond waters can also be attained through use of polyculture systems on prawn and shrimp farms.

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62. Modeling the Coastal Ocean--A Step Towards Marine Forecasting Capability

Dynalysis of Princeton, Inc., 20 Nassau Street, Princeton, NJ 08540

Lakshmi H. Kantha, Principal Investigator

NSF Grant No. OCE 81-13880 Amount: $28,050

Winds and tides are the most important driving forces in the dynamics of shallow coastal waters. Their effects need to be modeled correctly in any marine forecast model. Phase I will run the two-dimensional external mode component of the existing Dynalysis ocean circulation model for the Middle Atlantic Bight with tidal and wind forcing included. The object is to develop

and demonstrate the capability of the circulation model to incorporate these important effects by application to a small but well-developed coastal region. Results will be compared with available tidal and current data. By the end of Phase I, algorithms for inclusion in the fully three-dimensional Dynalysis circulation model will be available to be used in actual marine forecasting efforts in the subsequent phases of the program.

The potential commercial application as described by the awardee: The model could be applied to coastal shipping, commercial fishing enterprises, marine insurance companies, off-shore gas and oil drilling, off-shore dumping and pollution assessment, shoreline commercial enterprises (such as resorts) associated with recreational activities of the general public, port authorities, etc.

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63. Development of a New Management Technology for Commercial Prawn Farming: Phase I

Kahuku Prawn Company, Inc., P.O. Box 168, Kahuku, HI 96731

Spencer R. Malecha, Principal Investigator

NSF Grant No. OCE 81-13995 Amount: $29,853

Current prawn farming utilizes an inefficient system of stock assessment and manipulation. Laboratory-level experimentation suggests that this system underestimates the degree of animal-to-animal competition that develops within populations; large animals suppress the growth of smaller ones who have a high compensatory growth potential once they are consistently and periodically removed into their own size classes. A new management technology predicated on variable density culture during growout stages, stock division, manipulation and size grading, and more efficient sampling and harvesting is being studied. Such manipulation relies on the development of an appropriate approach for accurate sampling, sorting by size, high-density culture during juvenile stages, and harvesting, and considerably improves the accountability of stock not possible under current management practices. Research results should increase yields above those now obtained.

The potential commercial application as described by the awardee: Innovations which are to be the subject of the work proposed herein can be applied in any existing prawn farm operation to increase yield or profit per unit area by increased accountability of stock.

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64. Examination of Factors Affecting the Survival of Oysters Infected With the Fungus Labyrinthomyxa Marinum and Applicability of These Factors to Improved Pond Aquaculture

Research Planning Institute, Inc., 925 Gervais Street, Columbia, SC 29201

Geoffrey I. Scott, Principal Investigator

NSF Grant No. OCE 81-14489 Amount: $29,299

The objective of this study is to develop methods for reducing the mortality rate of the American oyster, Crassostrea virginica (Gmelin) in southeastern U.S. Present mortality rates are 50 percent in South Carolina. Infection by the marine fungus, Labyrinthomyxa marinum, is the most serious factor. By reducing or eliminating the high annual mortality rate, significant increases in oyster yields or meat production can be expected from southeastern states' coastal waters. Adult oysters will be field-collected from a tidal tributary in South Carolina and transported to a laboratory in Charleston, South Carolina. After being numbered, weighed, and measured, oysters will be placed in tanks and acclimated to running water. Fifty lab-acclimated adult oysters will be placed in each of a series of seawater tanks. Three control and three experimental tanks will be maintained throughout the entire period of study to properly estimate mortality. Two control and two experimental tanks will be maintained for physiological measurements of respiration, condition index, gonadal index, shell and tissue histology, heartbeat rate, and presence density of L. marinum infections on days 0, 15, 30, 60, 90, and 120 of the experiment. During Phase I, the factors that cause growth of the fungus L. marinum in South Carolina pond culture will be systematically examined: (1) salinity, (2) temperature, (3) delay of spawning by temperature manipulation, and (4) exposure to low concentrations of fungicide (0.01-1.0 mg/l of chlorine).

The potential commercial application as described by the awardee: The potential for pond oysters culture has been established for the northeastern, middle, and southeastern Atlantic coastal areas. By reducing or eliminating the high annual mortality rate in oysters infected with L. marinum, significant increases in oyster yields or meat production are expected that will make pond culture a more profitable business.

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TOPIC 18

ENVIRONMENTAL TECHNOLOGY

65. Engineering Development of a Clean-Burning Residential Wood Stove

Flow Research Company, 21414 68th Avenue South, Kent, WA 98031

G.W. Butler, Principal Investigator

NSF Grant No. CPE 81-14020 Amount: $30,000

The research involves three objectives. The first is to identify and evaluate key problem areas in wood stove technology. Areas receiving attention include: (1) combustion temperature distribution to allow more complete combustion of the volatiles, (2) combustion uniformity and stability with a minimum of excess air, (3) burning rate steadiness and controllability, and (4) gasification. The second objective is to develop an elementary, physically consistent computational model to evaluate the range of combustion parameters to be encountered and to determine the sensitivity of the measurement techniques required. The third objective is to develop concepts for the design of a modular laboratory stove and detailed computational requirements for a second phase effort.

The potential commercial application as described by the awardee: The development of an efficient and pollutant-free residential wood stove will greatly affect the increasing air pollution problems and the rapidly expanding wood stove market.

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66. Basic Mechanism to Achieve Clean Combustion of Oil Shale in Fluidized Beds

Huey Corporation, 813 Brierwood Street, Morgantown, WV 26505

L.H. Chen, Principal Investigator

NSF Grant No. CPE 81-13362 Amount: $29,359

The objective of the research is a comprehensive analysis of the environmental impacts of fluidized bed combustion of oil shale from the standpoint of chemical reaction engineering. The following tasks are undertaken: (1) an extensive literature survey on oil shale, oil shale combustion, and fluidized bed combustion technology; (2) a study of the mechanisms of combustion of oil shale and formation and degradation of sulfur dioxide and oxides of nitrogen in a fluidized bed combustor; (3) thermodynamics and kinetic analysis of oil shale combustion, sulfur dioxide capture reaction, and the reduction reaction of the oxides of nitrogen; (4) analysis of the effects of operating conditions and bed design parameters on gaseous and solid pollutant emissions; and (5) conclusions and recommendations.

The potential commercial application as described by the awardee: Clean combustion of oil shale in fluidized beds can be provided.

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67. Inhibition of Microbial Growth on Activated Carbon Beds

JTC Environmental Consultants, Inc., 7979 Old Georgetown Road, Bethesda, MD 20814

John T. Cookson, Principal Investigator

NSF Grant No. CEE 81-14146 Amount: $29,588

The objective of this project is to investigate conditions for inhibition of microbial growth on granular activated carbon resulting from the propagation of an intermittent or continuous ultrasonic wave energy across carbon surfaces during their use in adsorption of organics from water. Factors being studied include frequencies of vibration and their energy levels as related to configuration of the carbon bed; relationships of void space, energy needed as related to bed volume and microbial growth reduction; and the potential role of ultrasonic energy in releasing or producing organic compounds during its application to reduce microbial growth.

The potential commercial application as described by the awardee: This system may be used for household activated carbon purification, refrigerated and other drinking water systems, purification in the food and beverage industry, and for applications to municipal water purification facilities.

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68. Inductive Heating of Spent Granular Activated Carbon

QED Corporation, 1254 North Main Street, P.O. Box 7209, Ann Arbor, MI 48107

David Mioduszewski, Principal Investigator

NSF Grant No. CEE 81-14091 Amount: $29,877.80

The objective of this project is to determine the feasibility of using inductive heating for regeneration of granular activated carbon used to remove organic contaminants from water. The basic energy transfer characteristics of inductive heating are being studied to identify parameters that control the process as a step toward estimating the feasibility of using the process on a commercial scale.

The potential commercial application as described by the awardee: Inductive heating of activated carbon regeneration would allow for a more widespread use of activated carbon systems for removal of organic contaminants in vapor and liquid phase streams and for recovery and reuse of certain chemicals.

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TOPIC 19

TUNNELING, DRILLING, EXCAVATION, AND DREDGING

69. Feasibility Study of a Novel Rock Tunneling and Excavation Method

Flow Technology Company, 21414 68th Avenue, South, Kent, WA 98031

Thomas O'Hanlon, Principal Investigator

NSF Grant No. CEE 81-14486 Amount: $28,700

Flow Technology Company (FTC) has originated a novel rock excavation method concept. This method combines the unique capabilities of existing FTC high-pressure waterjet equipment with a rock-fracturing technique that does not require the use of explosives. Unlike conventional rock excavation methods, the proposed FTC method is not limited by rock type, heading configuration requirements, or ground conditions. Also, it can maintain a continuous excavation cycle and uses quiet, compact equipment that is compatible with present materials handling, ground support,

and lining installation methods. It is estimated that this new rock excavation method can both improve productivity and greatly reduce costs relative to conventional methods. Preliminary analysis and laboratory testing have indicated concept viability; however, further research is required to determine whether the concept is feasible for full-scale testing and development. The objectives of this Phase I program are to define critical parameters affecting the method, develop a predictive model, verify the model by laboratory testing, and then use the model to evaluate concept feasibility.

The potential commercial application as described by the awardee: This research program can ultimately lead to a system capable of performing excavation and tunneling operations in areas presently not suitable for them, and allow development of previously neglected resources. Such a system would immediately benefit both the mining and construction industries and the Nation as a whole.

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70. Self-Resonating High Pressure Water Jets for Tunneling, Excavation, and Mining

Hydronautics, Inc., 7210 Pindell School Road, Laurel, MD 20707

Georges L. Chahine, Principal Investigator

NSF Grant No. CEE 81-14063 Amount: $28,711

This research is based on an innovative technique to augment the efficiency of high-pressure water jets in tunneling, excavation, and mining. It deals specifically with a passive disruption of a jet into slugs in order to produce high-frequency, high-pressure shock wave impacts. The approach is to use self-resonating chambers, which amplify and structure the jet turbulent shear layer. The efficiency of such a technique is assessed by comparing, on coal, cutting rates of two different self-oscillating jets and a conventional jet. The limiting reaching distance of these jets is investigated, and conclusions for the need of sheathing of the jet are drawn. The possibility of interrupting the jet at controlled frequency without the drawbacks of mechanical wear and losses is very interesting for economical enhancement of jet cutting rates.

The potential commercial application as described by the awardee: High-performance nozzles for tunneling, excavation, and mining could be incorporated into many of the existing mining machines. Future extension is possible for application to in-air jet clearing of hard materials.

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TOPIC 20

EARTHQUAKE ENGINEERING

71. In-Situ Determination of Damping of Soils

Advanced Technology and Research, Inc., 12213 Cedar Hill Drive, Silver Spring, MD 20904

Jigien Chen, Principal Investigator

NSF Grant No. CEE 81-13897 Amount: $29,989

Much progress has been made in recent years in the development of analytical procedures for evaluating the response of soil deposits under earthquake loading conditions. Successful application of these procedures, however, requires the use of representative soil properties in the analyses. The two primary dynamic soil properties are the shear modulus and the damping values, both of which vary as a function of the strain. The shear modulus is determined either by field methods or by tests on specimens in the laboratory. A field test for determining in-situ shear modulus at high strain amplitudes (range of strong ground motion earthquakes) has recently been developed. However, damping values, at present, can be determined only in the laboratory. The objective of this research is the development of an in-situ method to determine the damping characteristics of soil at both a low and high strain level using the Random Decrement technique. In this technique, the random vibration response of a transducer placed in a soil deposit which is subjected to random excitation can be used to measure damping. The results of the in-situ determination of damping are used to verify or modify the extrapolation techniques of the existing laboratory data of damping and to determine if the measured laboratory values of damping are consistent with those occurring in the field during an earthquake.

The potential commercial application as described by the awardee: General site investigation and study of response of soil deposits to earthquakes could be enhanced. An in-situ method could be used to determine damping characteristics of soil based on the Random Decrement technique.

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72. Seismic Hazard Assessment of Non-Structural Ceiling Components

ANCO Engineers, Inc., 9937 Jefferson Boulevard, Culver City, CA 90230

Peter E. Rentz, Principal Investigator

NSF Grant No. CEE 81-14155 Amount: $29,832

Non-structural failures more often than structural failures account for a greater part of the economic loss following earthquakes. Non-structural failures also pose a serious threat to safety for building occupants. To date, most emphasis in research has been placed on improvement of structural performance of buildings during earthquakes. It is now apparent that non-structural considerations are due more research attention. Lighting fixtures are always one of the first non-structural elements to fail during an earthquake. Falling fixtures are a threat to human life and can inflict secondary property damage. Nonetheless, manufacturers continue to design and install gravity-held ceiling and lighting fixtures which do not have adequate seismic restraint. Hence, new design specifications for such systems in seismic areas need to be developed. This study of the dynamics of ceiling and lighting fixture systems using a shake table is a first step in this process. Shake table testing is evaluated as a seismic hazard assessment method for non-structural ceiling components and as a method of evaluating restraints for these components. Such tests provide the basis for evaluating ceiling and lighting fixture products for manufacturers before marketing.

The potential commercial application as described by the awardee: Manufacturers of ceiling and lighting fixture systems may be interested in having their seismic restraint designs evaluated using shake table testing.

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73. Alternative Methods for Hazard Reduction in Unreinforced Masonry Buildings

Michael E. Durkin and Associates, 22955 Leonora Drive, Woodland Hills, CA 91364

Michael E. Durkin, Principal Investigator

NSF Grant No. CEE 81-13750 Amount: $30,000

The large inventory of unreinforced masonry buildings in seismic areas pose a serious threat to lives and property. It is the building type considered most vulnerable to damage in earthquakes, but least amenable to structural rehabilitation due to high cost and the limited economic resources of many owners and occupants of such older structures. There is often great difficulty in persuading owners to take steps to reduce earthquake hazards in old masonry buildings. This research investigates low-cost methods of hazard reduction in these buildings as alternatives to full structural renovation. It includes the development of more refined categories describing the significant architectural, engineering, planning, non-structural, and operational characteristics of these buildings. Specific hazard reduction possibilities in each of these areas are identified and evaluated, and a methodology is developed for the application of these methods to unreinforced masonry buildings.

The potential commercial application as described by the awardee: The research is designed to provide information leading to the development of a commercially viable methodology that would form the basis of a service providing the development of a usable set of earthquake hazard reduction measures tailored to specific building characteristics and available resources.

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74. Field Index Test for Estimating Liquefaction Potential

Geotechnical Engineers, Inc., 1017 Main Street, Winchester, MA 01890

Gonzalo Castro, Principal Investigator

NSF Grant No. CEE 81-14111 Amount: $29,653

Liquefaction of saturated sands has been responsible for considerable damage to structures in most large earthquakes. The advancement of the present state of the art in evaluating the potential for liquefaction requires that the present procedures be verified against actual performance during earthquakes. Also, there is a potential for the development of better field index tests on which empirical liquefaction criteria could be based. The following technical approach is proposed: (1) design and build a field liquefaction index test (FLIT) device for use in bore holes that would apply both monotonically increasing and cyclic shear stresses to the soil, and (2) perform field investigations, including FLIT and other existing field index tests, at sites with sand deposits that have been subjected to known earthquake shaking.

The potential commercial application as described by the awardee: The FLIT device can be applied to subsoil exploration for engineering purposes.

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75. Tomographic Assessment Techniques for Earthquake Engineering

Scientific Measurement Systems, Inc., 2808 Longhorn Boulevard, Suite 303, Austin, TX 78759

Ira Lon Morgan, Principal Investigator

NSF Grant No. CEE 81-13999 Amount: $29,942

The magnitude of the threat posed by the occurrence of earthquakes to human life, as well as to economics, can hardly be overemphasized. Construction in general, utilizing concrete structural components, constitutes an area of great significance in view of their potential vulnerability from such events. Also, due to the non-availability of accurate and non-destructive assessment techniques, their potential hazards are often undetected by current inspection methods. Computerized tomography techniques may prove to be of great aid in providing a method for damage assessment of existing structures, as well as for quality control procedures for newly established structures. Compton Interaction tomography may prove to be of significant usefulness in assessing objects of such physical configuration to prohibit the use of computerized tomography. This investigates the feasibility of these alternative techniques in the examination of massive objects, of sizes more relevant to problems encountered in the earthquake damage and hazard potential assessment. The laboratory's high-energy tomograph is used. The project determines the feasibility of detecting cracks, reinforcement bars, voids, individual rocks, and of the measurement of overall and local densities.

The potential commercial application as described by the awardee: Devices capable of measurements in the field will find widespread applications in the construction industry, bridge inspection, and petrochemical industry, in addition to the assessment of earthquakes.

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76. Comprehensive Computer-Aided Earthquake Analysis and Program Development for Business and Industry

Scientific Service, Inc., 517 East Bayshore, Redwood City, CA 94063

Robert Reitherman, Principal Investigator

NSF Grant No. CEE 81-14231 Amount: $29,035

This project tests the feasibility of a comprehensive computer-aided earthquake analysis technique for business and industry. The technique integrates and modifies existing economic, structural, geological, architechtural, and emergency planning models and data bases into a useful management tool suitable for use in the private sector. The usefulness of countermeasures, categorized as operational, non-structural, structural, behavioral, and financial, will be evaluated according to their cost effectiveness. The synthesis of the risk analysis and risk reduction findings are on the general level of an entire organization, rather than only at the level of an individual facility or function. The process of designing and analyzing earthquake countermeasures consists of two steps: (1) an initial schematic design of risk reduction and response measures, and modelling and analysis of their cost effectiveness to identify the most promising candidates; and (2) after management review of the summary of earthquake risks and countermeasures produced by the first-stage approximation, detailed and focused development of a program of risk reduction and response techniques then proceeds. The business participates in the process of producing the necessary information or judgments concerning essential functions, corporate objectives, organizational structure, economic utilities, trade-offs, etc.

The potential commercial application as described by the awardee: The analysis technique could be used directly in business and industry in-house or by consultants to formulate and implement earthquake programs. The research product will be a practical form for solving earthquake problems of the private sector.

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TOPIC 21

SCIENCE AND TECHNOLOGY TO AID THE HANDICAPPED

77. Impedance Test for Intramedullary Anchored Femoral Prosthesis Loosening

Advanced Mechanical Technology, Inc., 141 California Street, Newton, MA 02158

Bruce F. White, Principal Investigator

NSF Grant No. ECS 81-13936 Amount: $29,997

The use of intermedullary anchored femoral prosthesis for treatment of severe hip disorders is a relatively successful surgical procedure. However, many patients who receive such arthoplastic surgery must undergo revision surgery within a 10-year period following initial surgery. The need for such revision surgery is largely attributed to loosening of the stem of the prosthetic device. It has been suggested that early diagnosis of the prosthesis loosening may decrease the several associated risks such as infection and total failure of the prosthesis, and additionally allow prescription of limited weight-bearing, which would enhance the probability of bone regrowth and re-establishment of bone-cement/bone integrity. However, present diagnostic techniques using symptomology and radiographic techniques are often not sensitive enough to detect early loosening. The proposed approach is to use frequency-response testing (impedance testing) to detect system nonlinearities which would be characteristic of a mechanical system which has some degree of play. A program of experimental and analytical modeling and testing has been designed to investigate the feasibility of this concept.

The potential commercial application as described by the awardee: Post-operative care for arthoplasty patients could be enhanced and information provided which could lead to future improvement in total hip prosthetics and surgical methods.

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78. Biotechnical Multi-Electrode/Neuronal Interface

EMV Associates, Inc., 15825 Shady Grove Road, Rockville, MD 20850

James H. McAlear, Principal Investigator

NSF Grant No. ECS 81-14117 Amount: $29,904

The researchers demonstrated the feasibility of fabricating arrays of biologically active materials with pattern densities approaching neuron densities in living nerve tissue. They are fabricating spot-patterned polylysine arrays using the proven electron-beam writing technique. Spot sizes between 0.1 and 10 microns are being used. On these arrays, neuroblasts are being grown. The evaluation of degree of neuroblast attachment culminates the initial research phase.

The potential commercial application as described by the awardee: Interface of integrated circuits to central nervous system may be achieved.

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79. The Study of Fatigue Mechanisms in a 3-D Carbon-Carbon Composite

Fiber Materials, Inc., Biddeford Industrial Park, Biddeford, ME 04005

John N. Pepin, Principal Investigator

NSF Grant No. ECS 81-13723 Amount: $29,854

This research program seeks to learn the failure mechanisms of multi-directionally woven carbon-carbon composites when subjected to fatigue loading, and to characterize this material's potential for use in internal prosthetic devices, e.g., hip and knee implants. The major objectives in this initial phase are to: (1) discover failure mechanisms and fatigue strengths of a typical fine weave 3-D carbon-carbon to determine which parameters (density, matrix pocket shapes, etc.) bear most heavily on fatigue life, where the breakdown is occurring and at what stress level, cycle, etc.; and (2) make quantitative assessment on the suitability of multi-directional carbon-carbons for implants from a strength and fatigue properties point of view. If this preliminary work shows a potential for carbon-carbon, follow-on effort will focus on all the design parameters for specific applications, such as hip or knee implants.

The potential commercial application as described by the awardee: The research may result in the development of improved hip and knee implants.

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80. Natural Gum Substitute for Karaya Gum for Ostomy Products

Technology Transfer Concepts International, 1303 American Drive, Neenah, WI 54956

Arun K. Chatterji, Principal Investigator

NSF Grant No. ECS 81-14235 Amount: $30,000

A family of natural gums is being studied to find a suitable substitute for Karaya gum that is inexpensive, plentiful, and more acid-resistant than Karaya. These gums are uniquely analogous to Karaya and have been used for other applications. The research plan consists of using a novel cryogenic grinding, followed by proprietary fabrication, under very controlled conditions, into ostomy discs for rheological and microbiological evaluation and cross comparison with the ostomy discs of Karaya and of synthetic polymer compositions. The plan provides for correlating the structure-property-performance relations of the successful gums and the ostomy discs made of these gums.

The potential commercial application as described by the awardee: Successful substitution of present ostomy discs with a natural gum substitute will result in an economic benefit.

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81. A New Signal Processing Concept Applicable to Hearing

Time/Space Systems, 240 Ridgefield Road, Endicott, NY 13760

John K. Bates, Principal Investigator

NSF Grant No. ECS 81-14258 Amount: $30,000

The research is based on the observation that fourier spectral analysis is inadequate to explain all abilities of the human to process acoustic signals. The hypothesis is that temporal processing, using a low-dimensional signal representation, is needed to characterize mixed epochs and short bursts of sound. A break board system to simulate the hypothesized performance of the ear based on known cochlear components is being constructed. The signal processing of this simulator is controlled by a proprietory algorithm called periodicity sorting matrix (PSM), which is postulated to simulate some of the neural processing capabilities of a human. A series of experiments of the classic type used in psychoacoustics is being conducted. These include two-tone masking

(suppression), combination tones, missing fundamentals, periodicity pitch, and phase masking. Additional experiments are planned if results of initial research validate the hypothesis.

The potential commercial application as described by the awardee: Applications include aid for hearing instruction; hearing aids; cochlear implant; laboratory instruments for speech and acoustic research; automatic speech and speaker recognition; and bandwidth compression/vocoder.

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TOPIC 22

APPROPRIATE TECHNOLOGY

82. Integrated Energy-Agro-Waste Systems for Small-Scale Farms

Cal Recovery Systems, Inc., 160 Broadway, Suite 200, Richmond, CA 94804

Luis Diaz, Principal Investigator

NSF Grant No. ISP 81-13803 Amount: $29,899

The purpose of this project is to investigate systems and potential for maximizing overall efficiency of food production on farms of less than 100 acres. Consideration will be given to all aspects of farm operation as categorized into the general areas of farm production, nutrient source, energy utilization, and residue disposal. Each area will be modeled to arrive at an overall model for a farm system composed of appropriate subsystems, i.e., a model for an integrated energy agrowaste complex.

The potential commercial application as described by the awardee: An integrated system of farming will be implemented that will improve the overall efficiency and economics of production of meat, food, and dairy products.

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83. Ecological Principles of Stability as a Means of Understanding the Role of Appropriate Technology in Agriculture

Dow Associates, Inc., 2855 Telegraph Avenue, Berkeley, CA 94705

Berah D. McSwain, Principal Investigator

NSF Grant No. ISP 81-14050 Amount: $29,664

The purpose of this project is to investigate the requirements for ecological stability of farms in the United States. The research should provide information useful to the U.S. agricultural community. Review of the agricultural literature shows that for many crops, economy-of-scale limits are reached at very small farm sizes (four to six employees). Yet actual farm sizes for these crops are much larger. The requirement for an information delivery system will be specified in Phase I.

The potential commercial application as described by the awardee: It could provide for an information system and information delivery system for the U.S. agricultural community, which would be the major user of and transfer agent for the information.

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84. Reducing/Separating Recoverable Demolition Wastes with Cavitating Water Jets

Hydronautics, Inc., 7210 Pindell School Road, Laurel, MD 20707

Andrew F. Conn, Principal Investigator

NSF Grant No. ISP 81-14064 Amount: $30,000

The purpose of the project is to determine whether cavitating water jets can economically cut demolition materials. If shown practical after laboratory tests on debris obtained from actual demolished buildings, these jets could be incorporated into small-scale equipment to provide on-site rubble reduction and to make possible separation of recyclable materials.

The potential commercial application as described by the awardee: Small, medium, and large-scale systems for recovering reusable materials from building demolition waste can be developed.

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85. Rate of Biodegradation of Toxic Organic Compounds While in Contact with Organics Which Are Actively Composting

Snell Environmental Group, Inc., 1120 May Street, Lansing, MI 48906

John R. Snell, Principal Investigator

NSF Grant No. ISP 81-13992 Amount: $30,000

The purpose of the project is to biodegrade about 60 toxic organic wastes and determine the degree of breakdown in different time periods, while in contact with high-rate composting. This will help to determine what toxic compounds normally found in municipal waste can be safely treated by composting, thus making them recyclable.

The potential commercial applications as described by the awardee: (1) Pretreatment of sewage solids, municipal solid wastes, or agricultural wastes to destroy toxicity before being recycled on the soil or otherwise into the food chain; (2) a possible means of low-cost pretreatment of toxic wastes by adding them into composting operations; (3) a means of concentrating volable toxic wastes for further treatment, recycling, or disposal, and (4) a means of accelerating testing of possible degradation that takes place in the soil.

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86. Characterization of Three-Metal Galvanic Cells in Seawater

Thomas C. Wilder, 80 Bacon Street, Waltham, MA 02154

Thomas C. Wilder, Principal Investigator

NSF Grant No. ISP 81-13932 Amount: $29,691

The purpose of the project is to study the corrosion behavior of three-metal galvanic cells intended for use as a timed release device in seawater. It would consist of three components: the active member, the noble member, and the strength member, which falls between the other two in the galvanic series in seawater. The selection of metal combinations for three-metal galvanic cells will be based on: (1) the proper electrochemical characteristics; (2) platability (i.e., adherence of deposit, uniformity of coverage); (3) freedom from room temperature interdiffusion of the candidate metals; and (4) predictability and consistency of corrosion behavior.

The potential commercial application as described by the awardee: Applications include the disabling of passive fishing gear such as traps or seines if lost or abandoned, and the automatic release of subsurface instrumentation.

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FOLLOW-ON FUNDING COMMITMENT ***

This solicitation is designed, in part, to provide **incentives for the conversion of Federally sponsored research to technological innovation in the private sector.** The Federal research can serve as both a technical and pre-venture capital base for ideas which may have commercial potential. **Proposers are asked to consider whether the research they are proposing to NSF also has commercial possibilities either for the proposed application or as a base for other applications.** If it appears to have such potential, proposers are encouraged, **on an optional basis**, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the Government funded research phases. Government funding pays for research on Federal objectives (Phases I and II), private funding pays for commercial objective efforts (Phase III).

The commitment for follow-on venture capital* or other funding** **must be obtained from a third party** of the proposer's choice. It is understood that the commitment will be **contingent upon the research achieving certain technical objectives** mutually agreed upon between the small business and the provider of the follow-on capital. **A few clearly defined and measurable objectives should be stated in the commitment agreement at the threshold level that would justify private investment if those technical objectives were achieved in Phase II.** The objectives do not have to be the same as those stated in the proposal, but they must be able to be accomplished within the scope of the proposed Government-funded research.

Proposers in Phase I should briefly describe any potential commercial application and whether they plan to secure follow-on private funding from a third party to pursue continuing development toward commercial objectives. A signed contingent commitment between the small business and a third party of its own choice is requested following submission of the Phase II proposal which must be received no later than June 30, 1982. Both the statement of potential commercial application and the commitment are optional but will receive extra consideration as points of merit in the evaluation process when other factors are of reasonably equal merit. **The maximum value (in Phase II evaluation) will be given for a signed formal agreement with reasonable terms and funding equal to or in excess of the Federal investment in Phase II.**

Phase III funding also may be advanced and invested during Phase II to accelerate the research and development process.

Source of Funding

The commitment agreement may be from a financial institution, such as a venture capital firm or a Small Business Investment Company (SBIC), if the small firm wishes to pursue commercialization of any resulting product itself. An alternative option is for the small business to obtain a commitment from a manufacturer already in the field. This coupling would utilize the small firm for the innovative R&D phases, and, through licensing or technology acquisition by the larger firm, the know-how and capabilities of the larger firm for production, marketing, and continuing financing in return for Phase III funding and a royalty agreement. This coupling to a larger firm already in the field may be one of the fastest, most capital-efficient, and lowest risk ways to bring new innovative technology to the marketplace. A commitment from a third party to form a joint venture with the small business for Phase III also may be used.

Objectives of Follow-on Funding

The use of the third party has a number of objectives. These include (1) providing a more objective opinion of the market potential of the research and technology because the third party must consider a substantial potential investment and (2) creating strong incentives for private investment in R&D in technological innovation and in small science-or technology-based business. Each can be facilitated through the government front-end funding of the highest risk area (research) which, if successful, should lower the risk for follow-on private investors to pursue possible commercialization.

The approach initiates consideration of technology transfer of Federal research to the private sector from the beginning of the research planning effort. This should be far more effective than transfer after the R&D has been completed or the actual hardware or software produced solely for Federal requirements.

*As defined by Section 107.202(b) of the SBA Rules and Regulations on venture capital financing which includes: "(1) common and preferred stock and equity securities with no repurchase requirement for five years, (2) any right to purchase such stock or equity securities, (3) debentures or loans (whether or not convertible or having stock purchase rights) which are subordinated (together with security interest against the assets of the small concern) by their terms to all borrowings of the small concern from other institutional lenders, and have no part amortized during the first three years."

**An acceptable alternative is a contingent contract from, or a joint venture with, a third party to fund the follow-on development effort in lieu of providing venture capital.

***From NSF Small Business Innovation Research Program Solicitation, NSF 80-85, pp. 31-32.

Most important, the approach provides a number of incentives for small science and technology firms, and possibly for venture capital firms and large manufacturers interested in investment and technology acquisition as well. It encourages further development of NSF research, the obtaining and investing of venture capital or equivalent funding, and the coupling of Federally supported research to the needs of U.S. small and large industry. Where successful, the approach will increase the return on investment and the socio-economic benefits to the nation from Federal R&D.

The Commitment

The Phase II follow-on funding commitment is due **within 90 days** following the end of Phase I period of performance. It should be submitted to the Program Manager for Innovation and Small Business, Room 1121, NSF, Washington, D.C. 20550. This is to provide time for discussion with potential investors during Phase I and actual negotiation following the availability of the Phase I final report which can provide a better assessment of the technical feasibility of the concept. The commitment agreement should **state,** on a contingent basis, that the investor will provide venture capital or other funding for follow-on development of the idea immediately following the NSF-funded Phase II so that the innovation process can continue without interruption toward commercialization. **The agreement should set forth the specific amount of Phase III funds that will be made available to the small firm contractor and the dates the funds will be made available. It should also contain a few specific technical objectives** which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires.

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